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On the Expansive Working of Steam in Locomotives. By DANIEL KINNEAR CLARK, C. E.—(*With a Plate.*)*

[Abstract of a Paper read at the Institution of Mechanical Engineers.]

Continued from page 11.

It is now proposed to consider the conditions on which the expansive working of steam in locomotives may be most beneficially carried out.

The condensation of steam in the cylinder by exposure, which takes place in certain arrangements of locomotives, is susceptible of proof in various ways: by the internal evidence of the indicator diagram, in respect of its general form, the form and course of the expansion line, and the back pressure; also by a comparison of the volume of sensible steam which is found to pass through the cylinder, with the volume of water found by measurement to be consumed from the tender and the boiler. The evidence of the expansion line of the indicator diagram will be first considered, both for well protected and partially protected cylinders.

Evidence of the Expansion line of the Indicator Diagram.—As the total heat of saturated steam is nearly constant for all pressures, being slightly greater the higher the pressure, there can be no condensation of steam during expansion, in a perfectly non-conducting vessel, but rather a slight surcharge. The surcharge is so slight, however, as not to require further

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notice in the present inquiry; we are only concerned in showing that perfectly protected steam under expansion, without any deduction from, or accession to its heat, continues substantially in a state of saturation, and unaltered in quantity or mass; and that if the indicator diagram show that at the end of expansion the final quantity of sensible steam is either greater or less than the initial quantity at the beginning, and surcharge by condensation or otherwise must have taken place in the condition of the expanding steam. The initial and final quantities, or their equivalents in water, are readily found by dividing the capacity of the cylinder and the clearance occupied by the steam, by the relative volumes due to the initial and final pressures. By the same law we may find the expansion curves, which would be described with a constant quantity of saturated steam under expansion; this has been done for the slow diagrams from No. 13, C. B., (Plate I. fig. 1,) and the curves of simple saturation thus found are shown in dotting. The deviations of these from the actual curves are all referable to one cause—*the condensation of the steam.*

In No. 1, the cylinder must have been at a lower temperature than the steam during the admission, and some condensation must have taken place, for no sooner is the steam cut off, than condensation is made visible by the sinking of the expansion curve below the standard throughout the whole of its length. In No. 2, also, this takes place to a small extent for the first half of the curve, when the temperatures of the steam and the material of the cylinder become equal; after this, as the pressure continues to fall, and the temperature of the steam with it, the curve rises and meets the standard curve at the end, in virtue of a partial re-evaporation of the steam previously precipitated, caused by the cylinder itself, which, colder than the steam, and heated by it in the first stage of the expansion, is now relatively hotter, and partially restores the heat of which it had previously robbed the steam.

In Nos. 3 and 4, the process of successive condensation and re-evaporation is still more distinctly brought out. In these cases, the greater portion of the heat engaged in the restoration of the steam during expansion must have been absorbed by the cylinder, by condensation of the steam during admission. Under the 3d and 4th notches, the observed final equivalents are shown to exceed the initial by 19 and 45 per cent. of the latter respectively; which proves that, in the two cases, at least 19 and 45 per cent. of the steam admitted *must have been condensed during admission*, as the additional steam can have been obtained from no other source. Although the actual expansion curves, Nos. 3 and 4, indicate much higher mean pressures *during expansion*, than the standard curves, and may so far be viewed as superior results, the favorable difference is only a partial amends for the much greater loss by initial condensation; and an expansion curve may be constructed backwards, in terms of the indicated mass of steam at the end of the expansion, to show from what initial pressure this mass of steam could have expanded, had there been no condensation. Take No. 4, for example. The final pressure at G is 13 lb., for which the relative volume is 939, and the ratio of the initial and final total volumes, or the degree of expansion, is 1 to 2·66; then $939 \div 2{\cdot}66 = 353$, which is the relative volume for 66½ lb. steam at the point of suppression. Tracing the expansion curve G H for this pressure, as in the drawing,

for which any number of intermediate points may be found in the same way, and drawing a horizontal admission line H I to the beginning of the stroke, the extra shaded area so inclosed is a representation of the real loss incurred by initial condensation of the steam; and, without going into figures, it appears nearly as much again as the area or power actually obtained.

The diagrams just discussed are, of course, extreme cases, which might occur in any cylinder, outside or inside; and they have been selected simply for purposes of illustration. They have served to show in what way the expansion curves of indicator diagrams may be turned to account in developing the condition of the steam. Our business is now to find to what extent, in the ordinary working of locomotives, the condition of the steam is affected by the circumstances of the cylinder.

The first point is to show, by the expansion line, that in well protected cylinders the steam is not subject to condensation. Referring to the 26 diagrams obtained from the *Great Britain*, of which the cylinders are suspended in and freely surrounded by the hot gases in the smoke-box, it appears that for each notch the influence of speed on the relation of the initial and final water equivalents of the steam expanded is nearly inappreciable. Dealing therefore with the means, the mean differences by which the final are less than the initial equivalents are—

For the 1st notch 3 per cent. of the initial equivalent.
" 3d " $5\frac{1}{2}$ " " "
" 5th " $2\frac{1}{4}$ " " "

These per centages are practically nothing, and the virtual constancy of the mass of expanding steam during expansion, thereby proved, shows that for the greatest observed degrees of expansion in the cylinder of the *Great Britain*, no change in the condition of the steam is observable, and that there is, consequently, no condensation at all.

Experiments made by the writer on some of the engines of the Edinburgh and Glasgow Railway, with inside cylinders, lead to the same conclusion.

Numerous diagrams were obtained by the writer from the outside cylinder engines of the Caledonian Railway, of which the cylinders are placed beyond the direct influence of the heat in the smoke box, and considerably exposed to the atmosphere. Seventy-six were selected as average samples of diagrams obtained during the regular work of the engines. These have been analyzed in the way adopted for those of the *Great Britain*, and the mean results range from 9 per cent. deficiency, to as much as 67 per cent. excess at the greatest expansion. Specimens of the diagrams from No. 42, passenger engine, and from No. 125, goods engine, are given in fig. 2. These diagrams were taken by McNaught's Indicator, and the dotted lines show the actual curves which are affected by the oscillation, to which that indicator is subject at high velocities. The mean lines have been drawn on the diagrams on the principle which the writer has satisfied himself applies in the particular case of the indicator—that action and re-action are equal, and that therefore the mean line, or radical form, ought to inclose the same collective area of diagram as the fluctuations in the lines actually described, due partially to momentum, cutting off at one place as much as it incloses at another.

For the greater ratios of expansion, the final equivalent of the steam is much above the initial, and the greater the ratio the greater is the per centage of this excess, amounting to 67 per cent. with an expansion of $3\frac{1}{3}$ times. This relation is just what was found for the slow diagrams from No. 13, and there is no doubt the excess of steam, at the termination of the expansion, is due to the same cause, namely—the condensation of the steam in the cylinder during admission, and during the first part of the expansion, and the subsequent re-evaporation of a portion of the precipitated steam. During the experiment, there was at all times ocular demonstration of the existence of water in the cylinder, in the spray which escaped from it through the indicator, and *which was given off more abundantly the more expansively the steam was worked.*

To find the general rate at which the per centage of condensation increases in these engines with the degree of expansion, the results obtained may be referred, as ordinates, to a base line representing the ratios of expansion. Let A B, fig. 4, be a base line divided to represent the total volumes by expansion in terms of the initial volumes; and from B draw the vertical scale to measure the relative per centages of condensation. From A set off on the base line the ratios of expansion, and for each ratio set off perpendicular distances by the vertical scale, equal to the respective per centages of the differences of water equivalents, col. 13, and define their extremities by points, setting off *minus* per centages below the line, and *plus* per centages above. The mean line C D, drawn through these points, is straight, and represents the mean rate at which the indicated condensation increases with the degree of expansion. It is found to meet the vertical from division 1, at 20 per cent. below, crosses the base line at a volume of 1·53, and terminates at E, the point due to an expanded volume of 3·4, and to a per centage of 70, and would, if produced, meet the vertical from B, at $92\frac{1}{2}$ per cent. The straightness of the line implies that the indicated per centage of condensation increases uniformly with the relative volume by expansion. For an expansion of 1·53 times, the per centage of condensation, or indicated difference of equivalents, is nothing; and, generally, for expansions advancing by half volumes, the per centages are as follows:—

Expanded volumes, the initial volume being — 1.	Indicated per centages of condensation.
1·5	$-1\frac{1}{4}$
1·53	0
2	$17\frac{1}{2}$
2·5	$36\frac{1}{4}$
3	55
3·5	$73\frac{3}{4}$
4	$92\frac{1}{2}$

For every half volume of expansion there is an increase of $18\frac{3}{4}$ per cent. of indicated condensation, and this becomes so serious that for an expansion of four times, if this were practicable with ordinary valves and link motions, there would be $92\frac{1}{2}$ per cent. of loss by condensation, or a loss of nearly one-half of the total quantity of steam admitted.

For ready reference, it is expedient to find the relative expansion and indicated condensation for different periods of admission, yielded by ordinary link motions. The following table contains in col. 2 the total ex-

pended volumes due by the nature of link motion to the several periods of admission in col. 1, and col. 3 contains the relative indicated per centages of condensation due to these expansions, measured from the diagram.

Of the Indicated Condensation of Steam in Outside Cylinders during the Admission of Steam.

Period of admission in parts of the stroke.	Total volume by expansion, the initial volume being = 1.	Indicated condensation, in parts of the indicated steam cut off.	Approximate proportion of steam condensed.	
			In parts of the INDICATED steam consumed.	In parts of the WHOLE steam consumed, (including the condensed steam.)
Per Cent.	Ratio.	Per Cent.	Per Cent.	Per Cent.
75	1·22	—12·0	12	11
60	1·40	— 5·2	12	11
50	1·54	0·0	12	11
40	1·78	9·4	21	17
30	2·07	19·9	32	24
20	2·45	34·1	46	32
12	3·17	66·1	73	42
1	**2**	**3**	**4**	**5**

Though the losses shown in the 3d column are great, the real losses must be still greater; because the restoration of condensed steam, by which the losses have been measured, cannot be entire. The indications, indeed, fail to show any loss at all, at 50 per cent., as the re-evaporation balances the condensation during expansion. For 75 per cent., the re-evaporation (if any) is so slight as to leave a deficit of 12 per cent., by condensation, during expansion, compared with what was indicated as cut off. Now, the whole tenor of the evidence shows plainly that the degree of condensation increases as the admission is shortened; and it may be safely inferred that as 12 per cent. is shown to be lost in full gear, there is at least 12 per cent. of loss for 50 per cent. of admission, cutting off at half stroke. An approximate loss of 12 per cent. will, on this ground, be adapted for all admissions greater than half stroke; and 12 per cent. will also be added to the indicated losses for shorter admissions, as an approximation to the real conditions.

Col. 4 contains the approximate losses as thus revised, in parts of the *indicated* steam admitted. Adding the *lost* steam admitted to that indicated, the sum expresses the *whole* steam admitted and expanded; and col. 5 contains the per centage of approximate loss, expressed in terms of the whole steam so used, which is a more convenient form for reference. From this column it appears that for 40 per cent. admission, 17 per cent., or one-sixth of the steam, is condensed; for 30 per cent., one-fourth; for 20 per cent., one-third; and for 12 per cent., or mid gear, two-fifths, or not far from one-half.

It must be added that the foregoing deductions are based on steam pressures under 60 lbs., generally about 50 lbs., during admission. For higher pressures, and admissions above half stroke, the condensation is proportionally less, as will afterwards be shown.

Proof of the Condensation of Steam in Outside Cylinders, by comparison of the indicated consumption of steam with the measured consumption of water.—Many experiments were made by the writer on this point; one was made with No. 42, passenger engine, on the Caledonian Railway, during a trip of 105 miles, from Glasgow to Carlisle, with an average train of 6½ carriages, done in three hours 22 minutes, five stoppages included. Indicator diagrams were taken from the cylinder at intervals of one or two miles, and the notch of the expansion gear observed for each diagram, and the points of the line where each change of notch was made.

The several points of cutting off, expansion, and compression were accurately ascertained by means of the slow diagrams; from which were calculated the exact quantities and pressures of sensible steam actually consumed in each interval of the trip, and the water equivalents for the several quantities of steam present in the cylinder; which, multiplied by the number of strokes of the two cylinders in each interval, gives the total quantity of water efficiently used as steam. The following final results were thus obtained:

Distance traveled.	Water used as sensible steam.	Water consum'd as measured.	Excess.
1. Glasgow to Motherwell, . .	30·76 ft.	35·82 ft.	5·06 ft., or 14 per cent.
2. Motherwell to Carstairs, .	43·91 ft.	48·85 ft.	4·94 ft., or 10 do.
3. Carstairs to Beattock, . .	57·28 ft.	67·74 ft.	10·46 ft., or 15½ do.
4. Beattock to Carlisle, . .	62·42 ft.	79·50 ft.	17·06 ft., or 21½ do.
Total, Carlisle to Glasgow,	194·37 ft.	231·91 ft.	37·54 ft., or 16¼ per cent.

The examination of the indicator diagrams in the manner employed before, by comparing the initial and final water equivalents of the steam during expansion, shows that at least 13 per cent. of this loss of 16¼ per cent. was due to condensation, and it is probable that no appreciable proportion was due to priming; indeed, the *least loss* was observed to take place with the least degree of expansion, and when the consumption of steam from the boiler is going on at the *greatest rate*, as we find on referring to the per centages of admission; which is the reverse of the effect that would be observed if priming were a material cause.

Experiments made by the writer with other outside cylinder engines, *or imperfectly protected* cylinders, corroborate the above deduction obtained from the performance of No. 42; and they are still further corroborated by his experiments on inside *well protected* cylinders, which show that in ordinary good condition there is no sensible excess of water of any importance, actually consumed from the boiler, above what is estimated from the indicated steam passed through the cylinder. These results are also confirmed by the results of the trials of Mr. D. Gooch, with the *Great Britain* and similar engines.

The increased *back pressure of exhaust* affords additional evidence of the presence of water in the cylinder. The back exhaust pressure is the consequence of the want of facilities for the timely discharge of the exhaust steam from the cylinder; and the impediments to its discharge are much

increased by the presence of water amongst the steam, whether due to condensation or to priming. The presence of water is immediately made apparent by the increase in the back exhaust pressure, shown by the indicator diagram, as the writer has on many occasions had an opportunity of observing. The *effects of priming* from foulness of the water in the boiler are shown in fig. 3: A and B are indicator diagrams taken from the well protected cylinders of the *Orion*, in which very little, if any, condensation could be detected. The diagram A was taken *before*, and the diagram B *after* the boiler was blown off and supplied with clear water, both being taken at the same speed, and showing 7 lbs. back pressure caused by priming in the former case.

The diagrams C and D, fig.3, show that the *total quantity of water* from condensation is considerably greater, with the greater degrees of expansion, where a *smaller quantity of steam* is admitted, and consequently the loss is more seriously felt. These diagrams were taken from the outside cylinder goods engine No. 127, working at the same speed up and down an incline on the Caledonian Railway; the diagram C cutting off at two-thirds the stroke, and the diagram D at one-sixth of the stroke. The latter, D, though it had the advantage of a much earlier exhaust, and only one-fourth of the quantity of steam to discharge, was affected with 10 lbs. more back pressure than the former, C, when working in full gear. This great back pressure was maintained over a continued run of twenty miles, when of course the cylinders had got into their working heat for that degree of expansion; and the inference is, that the steam was loaded with water of condensation, (proved also by the expansion curve,) which was with difficulty expelled, and which only became proportionably less when the degree of expansion was diminished; and, consequently, the mass of steam increased that was to be cooled within the same superficies of cylinder.

That the *total mass of the steam* has much to do with the condensation is proved by the diagrams E and F, fig. 3, taken under the same degree of expansion, and at the same speed, but with 75 and 20 lbs. steam respectively admitted to the cylinder. In the latter diagram, F, the back exhaust pressure is 7 lbs. greater than in the former diagram, E, although the total quantity of steam to be discharged was so much less. In the latter case, indeed, there was found to be an excess of 18 per cent. of the whole water used over the indicated steam expended, which was most probably altogether by condensation, as the rate of consumption was so moderate as to preclude any likelihood of priming.

Now here is a case where, in the same class of engines, the back exhaust pressure *increases* as the quantity of steam to be discharged *becomes less*, notwithstanding that the facility for exhaust increases at the same time. This is clearly a case of water in the cylinder, the quantity of which increases with the degree of expansion; and the water is as clearly a precipitation of steam by condensation. Also, though a full admission of steam at higher pressures may reduce the proportion of condensation, yet whenever expansive working is attempted by cutting off earlier, the heavy back pressure and the course of the expansion line alike show that no pressure of steam, however high during the admission, can mitigate the evils of condensation in exposed cylinders.

Evidence from the Proportions of the Valve Gear.—The greater the lap of the valve, the greater also is the inside lead, for the exhaust exposed cylinder, we should expect, would therefore require longer laps than well protected ones, seeing that wet steam exhausts with difficulty. Accordingly, it has been found that in Sharp's inside cylinder engines, on the Edinburgh and Glasgow Railway, which have only a $\frac{5}{8}$-inch lap—probably the shortest lap in present practice for a 15-inch cylinder—the exhaust is as perfect as in the Caledonian passenger engines with $1\frac{1}{2}$-inch lap for the same cylinder. Further, in inside cylinders with clean boilers, it is practically a matter of indifference what amount of wear or slugger may have taken place in the valve gear, so far as concerns the exhaust: in outsides, on the contrary, it is a very important object to maintain the gearing in the highest order, so as to keep up the inside lead, as the wear of the gearing directly reduces the lead, and thereby increases the back pressure. The Caledonian is perhaps the first line in this country on which the special advantage of long lap for outside cylinders was experienced.

The formidable degree of condensation which accompanies high expansion in partially protected cylinders, accounts for the opinion held by men of experience of the inutility, for economical objects, of cutting off the steam earlier than at half stroke, for the proved advantage of expansive working in inside cylinders is neutralized in outsides by the condensation. Mr. Buddicom, of the Rouen Railway, led the way in the re-introduction of outside cylinders in this country: and to this day, he and some of his followers have adhered to the fixed gab motion.

Conditions on which the expansive working of steam in locomotives may be carried out with efficiency and success.—The first condition is to perfectly protect the cylinders, and to maintain them at a *temperature at least as high as that of the steam admitted to them.* Simple non-conducting envelopes are not sufficient; external supplies of heat must be employed, and the application of a steam jacket to the cylinder would be advantageous, when other sources of heat are not readily available. The writer tried an experiment with the *Orion*, Edinburgh and Glasgow Railway, which has its cylinders suspended in the smoke box, like the *Great Britain's*, in which, by the use of partitions, the hot air from the tubes was directed entirely round the cylinders, previously to its emerging by the chimney: but he could not detect the slightest change in the performance of the engine, probably because the hot air was really very little hotter than the steam, and the closer contact made no difference. For cylinders already well protected, more thorough modifications would be required to make a sensible improvement. The steam should also be surcharged, previously to entering the cylinder, by passing over an extensive heating surface, deriving its heat from the atmosphere of the smoke box, or, if necessary, from a hotter source.

Mr. W. C. Hare, of Stonehouse, Devon, to try the value of surcharging the steam, experimented on a small engine, with cylinder $3\frac{1}{2} \times 8$ inch stroke, and a boiler of 9 feet heating surface. He found that when the steam was passed over a surcharging surface of $5\frac{1}{4}$ feet in a coil of copper tube, and heated to 400° before entering the cylinder, the consumption of water from the boiler was three gallons per hour; and when the

communication with the surcharging pipe was cut off, and the steam led directly to the cylinder, the water used amounted to six gallons, or twice the other, while doing the same work, and involved a great increase of fuel consumed. To effect the reduction here noted, it appears that a surcharging surface equal to fully one-half of the heating surface has been necessary; and it is probable that for locomotives a considerable allowance must be made to produce a very decided change. The results of this experiment show that very much has yet to be done before the capabilities of the locomotive are fully developed.

As steam has been found so very sensitive to *exposure* on the one hand, and to *surcharging* on the other, it would probably be of advantage to *lead the hot smoke round the barrel of the boiler and the fire-box*, or the barrel only, *previously to its discharge by the chimney.*

The second condition of successful expansive working in locomotives is the combination of a sufficiently high boiler pressure of steam, with suitable proportions of cylinder and driving wheel, to admit of highly expansive working consistent with the required duty of the engine. It is probable that 150 lbs. per inch is about the highest pressure at which it is advisable to work a locomotive, consistent with the fair working and durability of its parts. The maximum pressure being settled, and it being assumed that the same pressure is to be maintained in the cylinder during admission, the degree of expansion to be adopted determines the capacity of the cylinder to develope the necessary average power. Long strokes are not advisable on the score of stability, at least for outside cylinders, and large diameters should rather be adopted; for the same reason, large wheels are preferable.

Thirdly, in the details of the mechanism, the cylinder should be arranged to have the shortest practicable steam-ways; as, for short admissions, a long steam-way deducts very much from the efficiency of the steam. Such an arrangement would be greatly promoted by the introduction of balanced valves, or such as have provision for preventing the steam pressure on the back of the valves; as, by being balanced, they could with facility be made large enough to embrace the whole length of the cylinder. The loads which ordinary valves are forced to carry on their backs are enormous; and though there is certainly no momentum in these loads to contend with, yet the friction of surfaces due to the loads is very great, even at the most moderate computation.

Discussion.—Mr. Stephenson (the Chairman) observed that he felt much obliged to the author of the paper for explaining in such a clear and practical manner the action of the slide valve and the link motion; and the paper was particularly valuable for the actual numerical results that were given so completely of the variations in practical working, showing the improvements effected and the defects avoided.

Mr. M'Connell agreed that the link motion was the most advantageous and useful of any valve motions known for locomotive engines. He thought a hot air chamber should be contrived, passing round the cylinders, to be kept at a temperature sufficient to maintain the steam perfectly dry.

Mr. Clark said, that in the Great Western engines, Mr. Gooch had

carried the steam pipe straight down in front of the tubes, instead of curving it on one side as usual; and the pipe being of $\frac{3}{16}$-inch copper, it absorbed the heat from the tubes rapidly, and surcharged or dried the steam.

Mr. Stephenson observed, that with regard to the question of surcharging steam, he remembered being told by Mr. Trevithick of an experiment which he made in Cornwall in 1830. He had to repair an old engine there, which had no steam jacket to the cylinder, as most of the other engines had, to keep up the pressure of the steam; and he built a brick casing round the cylinder, leaving an air space all round, and applied a small fire to keep this air heated. About one bushel of coals in twenty-four hours was consumed in heating the cylinder, and he found a great increase was effected in the duty performed by the engine, with the same consumption of fuel under the boiler as before. He then removed the fire from the cylinder, in order to find the relative efficiency of the coal when consumed under the boiler or under the cylinder, and he found that it took five bushels of coals applied to the boiler to produce the same effect as the one bushel of coals applied to the cylinder. Mr. Stephenson said, he had been so much impressed with the results of this experiment, that in the *Planet*, one of the early locomotives made in 1832, he had the cylinders carefully inclosed inside the smoke box, instead of being outside, and there was found to be a considerable increase of power effected by the plan. That was the first locomotive constructed with heated cylinders, and it appeared the principle ought never to have been deserted; but it was singular how temporary prejudices sometimes caused a good thing to be departed from. Those inside cylinders were abandoned because the crank axles were found liable to break; but then, after that objection was subsequently removed by improved manufacture, the prejudice against the inside cylinders still remained; however, they appeared now to be going back to them. The construction of locomotives was still perhaps much influenced by these local prejudices arising from individual circumstances; and he was confident that this Institution would conduce greatly to the removal of them, by the mutual interchange of ideas and experience that was promoted by it; and nothing could assist more in forwarding such a desirable object than the reading of such papers as the present one by Mr. Clark. He quite agreed with the opinion stated in the paper on the great drawback to the application of expansion in locomotive engines caused by the condensation, from the cylinders not being heated; he considered some additional heat was required to be supplied during expansion to prevent condensation taking place, as it appeared the quantity of heat in steam was not sufficient to maintain the whole in the form of steam during expansion, but a portion returned to the form of water, as shown in the able investigation of the expansion of steam given in Lardner's "Treatise on Heat."

Mr. Cowper described some experiments that had been made by Mr. Siemens and himself, which he thought showed that condensation did not take place during expansion. They took a cylindrical tin vessel closed at the top, about 12 inches high and 2 inches diameter, the metal of which was very thin, and coated thickly with felt outside to prevent any loss of heat. A small steam pipe was connected at the top, but the

bottom of the cylinder was open to the atmosphere; and a stream of 30 lb. steam was blown into the vessel from a very small orifice, and allowed to escape freely into the atmosphere at the open end of the cylinder. After a short time, when the cylinder had become hot, and was maintained just full with expanded steam at the atmospheric pressure, a thermometer inserted a short distance into the open end, showed a constant temperature of 214° to 215° instead of 212°, proving the total quantity of extra heat that is in high pressure steam; and no condensation could be perceived inside the cylinder, no vapor being visible until the steam had escaped from the cylinder into the atmosphere. This experiment was tried on several different occasions, and on one it happened that the boiler was priming slightly; and when a drop of water came over through the steam pipe and dropped upon the bulb of the thermometer, it was observed to fall suddenly to 212°, and remained at that point until the water was boiled off, when it again rose 2° to 3° above the boiling point as before.

Mr. Stephenson said he did not think that mode of trying the experiment would give a correct result as regarded the present question, as the steam was escaping into the atmosphere instead of being all confined within the cylinder, and the temperature in the cylinder being maintained above the boiling point would prevent any condensation taking place during the expansion of the steam.

Mr. Cowper did not think that in a cylinder thoroughly protected from loss of heat by radiation or conduction, any condensation of the steam would take place during expansion, and that if any condensation occurred, it would be found to be owing to the steam having lost some of its heat, which it could not recover. The result that he obtained by indicator diagrams from a pair of 35-horse power, high pressure, expansive, and condensing engines, which he had constructed some years since, fully bore out this view; the steam was expanded in the cylinder of each engine independently, and the practical expansion curve was obtained very accurately. The whole body of the cylinder was necessarily nearly at a mean temperature between the highest and lowest steam in the cylinder, (the cylinder not having a steam-jacket,) consequently the steam ought to be slightly cooled on entering the cylinder, and towards the end of the stroke, where it was at a lower temperature from expansion, it ought to be slightly warmed by the cylinder;—now the indicator figure showed both these circumstances to have taken place, for the actual curve during the first part of the stroke, after the steam had been cut off, was rather below the true expansion curve; and during the latter part of the stroke, it was rather above; this also showed that the expansion curve required a slight correction for the extra quantity of heat in the high pressure steam.

Mr. Clark remarked that he had found by the indicator diagrams that a great condensation of the steam took place in exposed outside cylinders during the first part of the stroke, from the coldness of the cylinders, and a considerable amount of condensation also was caused even in protected cylinders, where they were not artificially heated by exposure to the hot air in the smoke box, because the temperature of the mass of metal in the cylinder remained about the mean temperature of the steam

whilst expanding in the cylinder, which might be many degrees below the original temperature of the steam on entering from the boiler. This caused the actual pressure of the expanding steam to be below the theoretical pressure during the first half of the stroke, as shown in the indicator diagram, fig. 3; where the theoretical curve of expansion is shown by the dotted line BCD, allowing for the contents of the steam port and the clearance represented by the space AA. But about the middle of the stroke, the two curves coincide at C, as the steam was then at its mean temperature, and agreed with the temperature of the cylinder; and after that point, as the steam continued to expand and lower in temperature, the cylinder remaining nearly constant was hotter than the steam, and returned some of the heat it had robbed from the steam, re-evaporating more and more of the water that had been condensed, and raising the curve of actual pressure above the theoretical curve at the end D, where the exhaust commences. A portion of the lost steam is thus restored to the second half of the stroke, but a serious loss of power still remains; and the consideration of this action that is always going on to a greater or less extent in the cylinders of locomotives, however well they may be protected, except where they are artificially heated, shows what an important source of economy is to be found in carrying out that principle.

Mr. Crampton thought that enough attention had certainly not been paid to the condensation in the cylinders of locomotives at slow speed; he did not think it was of so much importance at high speeds. It was also particularly of importance in steamboat engines, where the question had not received so much attention as it deserved. He remembered an experiment which showed a remarkable effect of condensation; four condensing engines, of equal size, were working coupled together in a boat, with the steam cut off at one-quarter of the stroke and expanded; two of the engines were then disconnected, and the other two engines were worked, cutting off at half-stroke, using, consequently, the same quantity of steam as the four engines did, cutting off at one-quarter of the stroke; but a greater effect was found to be produced by the steam than when it was used in the four cylinders. This increase of effect appeared to be entirely due to the greater amount of condensation that took place in the four cylinders than in the two cylinders. There were no steam jackets, only ordinary clothing on the cylinders, and he thought much improvement was required in this respect in marine engines, and it was a matter well deserving the consideration of engineers. In reply to an inquiry, he said the boilers were working with salt water, but he did not think that would affect the result.

Mr. Peacock suggested, that part of the effect in the experiment mentioned by Mr. Crampton might have been due to the smaller amount of friction in the two cylinders than in the four cylinders, when giving out the same total amount of power.

Mr. Crampton replied, that a greater effect was found to be produced after allowance was made for the friction, by taking indicator diagrams, and the relative consumption of the water.

Mr. Whytehead thought the loss by back pressure would also be less in the case of the two cylinders than with the four.

For the Journal of the Franklin Institute.

To the Committee on Publications.

GENTLEMEN :—In looking over the December number of the *Practical Mechanics' Journal* for the past year, I see published therein the specification of a new Express Locomotive, recently built for and put in operation on the London and North Western Railway. In some remarks appended to the specification, some stress is laid upon certain improvements in the mode of constructing the boilers, alleged to have been made by Mr. McCORNELL, the designer of the locomotive in question. By referring to the annexed specification of a patent for improvements in steam boilers, granted to me in England more than a year ago, and which I would request you to publish entire, with this letter, it will be seen that the extension of the fire box into the waist of the boiler, upon which the merit of Mr. McConnell's boiler mainly rests, is not new with him. Nor is the idea new with myself, as I am aware that this same thing has been done in this country nearly fifteen years ago. It was also the subject of a patent in England, granted to Stubbs & Grylls, in August, 1846. In both the above cases the plan was abandoned as not useful, and in my opinion failed, from not carrying out the principle far enough. Whilst I was engaged in preparing my specification in England, in the autumn of 1851, and winter of 1852, two locomotive engines were altered under *my special direction*, by Mr. McConnell, at the workshops of the London and North Western Railway at Wolverton. One of the above engines was put in operation early in 1852, and *to my certain knowledge before the new express engines were commenced.* Upon the eminent success of these altered engines, the boilers of the new engines were prepared, the latter being identical in principle with the former, although somewhat changed in form. I have for many years past been satisfied that the use of such long tubes as are now prevalent in the construction of locomotive boilers, has been, and is, an error in principle, and I think the results which are now being brought out in England, prove my opinion correct. I believe fully, that tubes of ten to fifteen feet in length, as now so extensively, and I might say exclusively, used, will be eventually abandoned for those of half the length, or even less.

I remain, gentlemen, yours, very respectfully,

JOSEPH HARRISON.

443 *Arch Street, Philadelphia, Jan.* 17, 1853.

Specification of Improvements in Steam Boilers. By J. HARRISON, Eng.

To all to whom these presents shall come. I, Joseph Harrison, engineer, of the City of Philadelphia, in the United States of North America, but now residing at No. 10 Oxford Square, Hyde Park Gardens, in the County of Middlesex, send greeting: Whereas, Her Most Excellent Majesty, Queen Victoria, by her letters patent, under the great seal of the United Kingdom of Great Britain and Ireland, bearing date at Westminster the eighth day of December, in the fifteenth year of her reign, did, for herself, her heirs and successors, give and grant unto me, the said Joseph Harrison, her especial license, &c., &c.

Marine Boiler.—Chapter the first. Figures No. 1, 2, 3, and 4, sheet

No. 1, show an arrangement of boiler more particularly adapted for Marine Engines. This boiler, in general appearance externally, is not different from boilers now in use, but it will be seen by inspection, that the arrangement of the heating surface varies from the usual mode, these variations having been made with a view to obtain a more efficient kind of fire surface as well as to increase this surface without enlarging the size of the boiler. By reference to figures 1 and 2, it will be seen that the fire box is carried forward from the fire-place some distance into the interior of the boiler, to which it conforms in shape, and is surrounded with a water space, as shown in figure 3, sheet No. 1. The open space in the fire box above the fire is filled at certain intervals with horizontal tubes distributed as shown in figure 1, leading from the water space immediately over the fire doors to the extreme end of the part of fire box extending into the boiler as above described. These tubes have water covering their interior surfaces. After the flame and combustible gases have passed from the fire upward and through the intermediate spaces between the tubes just mentioned, it passes onward through a series of smaller tubes which lead from the external fire box to the smoke chamber C through the water space B. The smoke chamber C has a series of vertical tubes so disposed as to leave the tubes leading from the fire box free for cleaning from the front end of the boiler. The heating surface in the smoke chamber is arranged so that it may be used either for generating steam by surrounding it with water, or the water from the boiler may be shut off by shutting the holes leading from the water space B to the jacket of smoke box if required. In the latter case the smoke chamber is intended to be used for drying or surcharging the steam previous to its entering the cylinders of the engine. For which purpose the steam pipe D, figures 2, 3, and 4, sheet 1, may be arranged so as to bring the steam from the steam chamber E to the top of the smoke chamber, from whence it is brought in contact with the interior heated surfaces of the smoke chamber, and is discharged in its way towards the cylinders at the opening F, figures 2 and 4. Or the opening F, figures 2 and 4, being closed, and the surface of smoke box and interior vertical tubes being filled with water and used for generating steam in like manner with the other parts of the boiler, then the steam pipe D serves as a means of conveying the steam from the top of smoke box to the steam chamber E. After the combustible gases from the fire box have been brought in contact with the interior surface of the smoke chamber and the vertical tubes contained therein, they return again to the back end of the boiler through a series of tubes which lead from the smoke chamber to the chimney G, passing through the entire length of the series of tubes first alluded to in this description, as shown in figure 2, longitudinally, and in section in figure 1. Figure 5, sheet No. 1, shows a mode of making a fire box or boiler stay, which is intended to be used in the boiler just described, as well as in all the other arrangements of boilers hereafter to be mentioned in this specification. In place of the ordinary screw stay for connecting the exterior to the interior parts of the furnace or fire box, it is proposed to make a stay similar to fig. 5, sheet No. 1, which is fully explained at a single view in section. This stay consists of a wrought or cast iron tube, or of any metal of any given diameter and length suit-

HARRISON'S STEAM-ENGINES AND BOILERS.

Fig. 1—Sheet I.

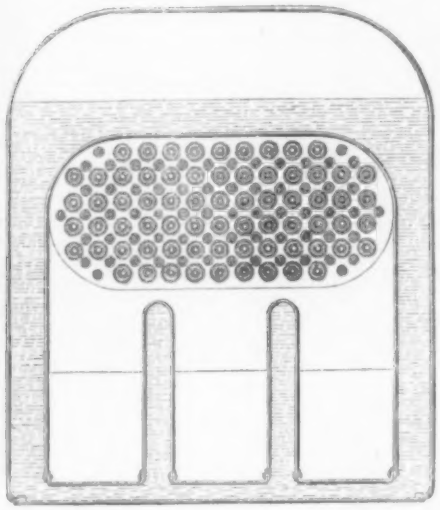


Fig. 3—Sheet I.

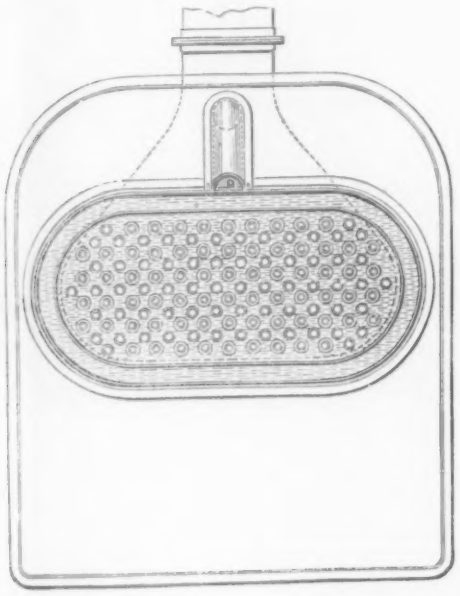
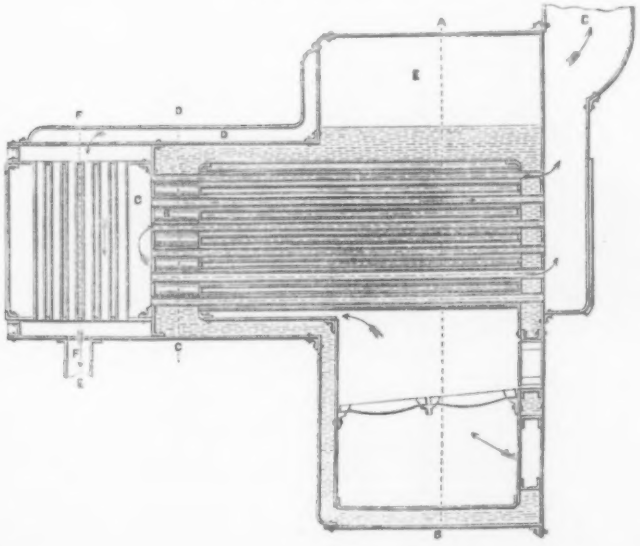


Fig. 2—Sheet I.



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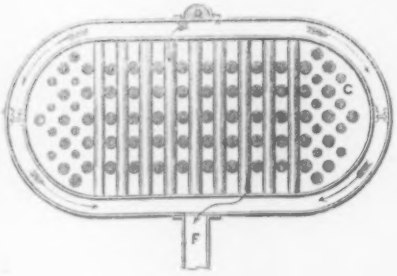

Fig. 5—Sheet I.

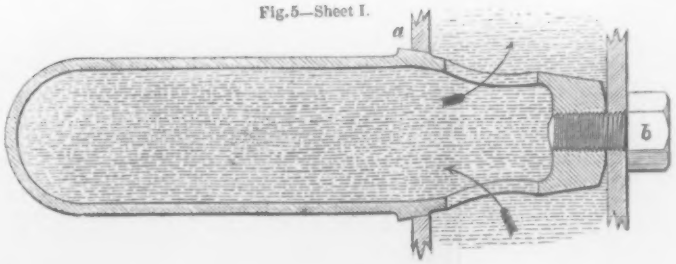

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Fig. 1—Sheet II.

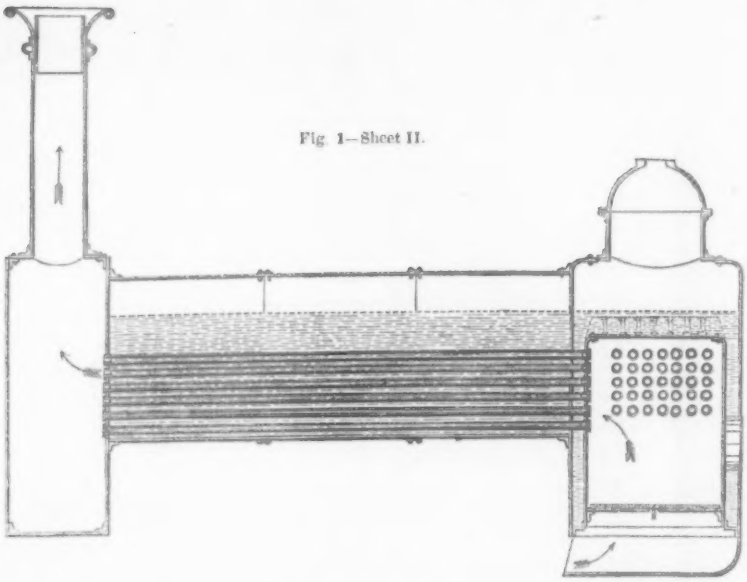


Fig. 2—Sheet II.

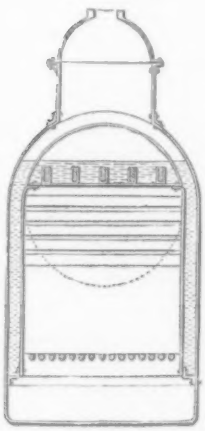


Fig. 4 - Sheet III.

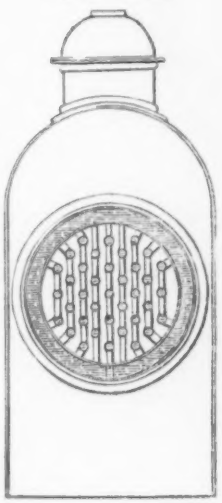


Fig. 3—Sheet II.

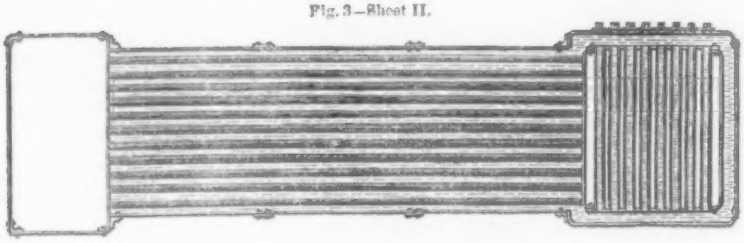


Fig. 1—Sheet III.

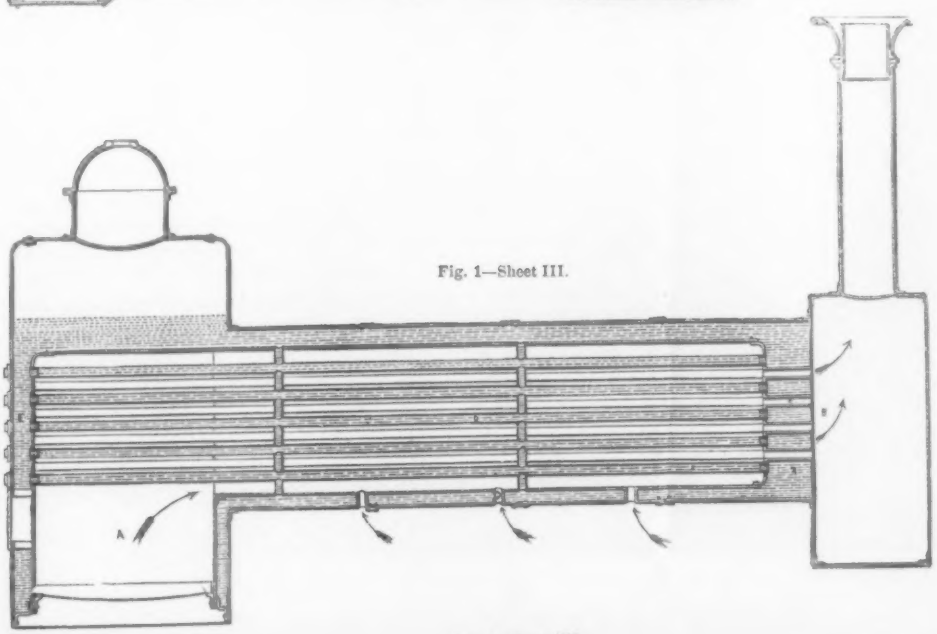
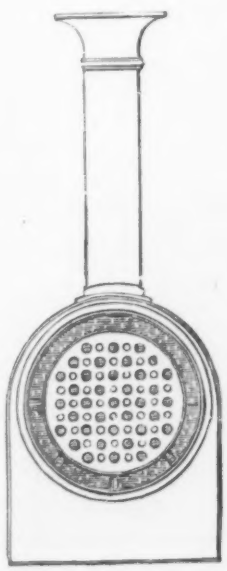


Fig. 2—Sheet III.



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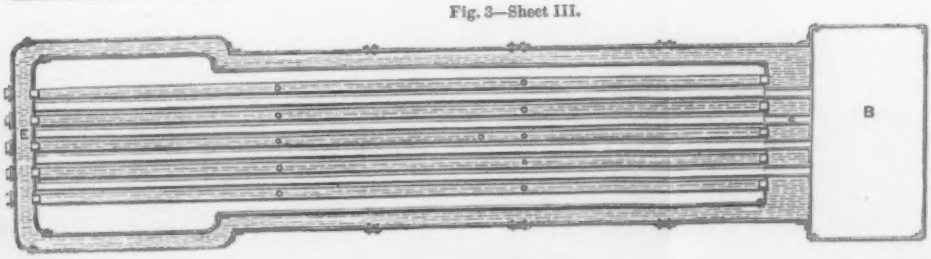


able to the place in which it is designed to be put; one end of this tube is closed so as to present a rounded end, the form, however, not being deemed essential. The contrary end which forms the stay is turned conical at the point A, and is made to fit steam-tight into a corresponding conical hole in the interior of the furnace, either above or in the vicinity of the fire. After passing through the interior sheet of furnace, this tube is prolonged until it reaches the interior side of the external sheet of the boiler or fire box. Directly opposite this tube a hole is bored through the exterior plate to allow a bolt to pass through, so as to draw the tube tight into the conical hole, thereby connecting the inner and outer surface of fire box, and making a secure stay. Free circulation is made into the interior of this stay by two or more holes made through the portion of the tube in the water side, which permits free ingress of water and egress of steam in the direction of the arrows. The object in making the stay in this form is to secure the very efficient fire surface surrounding the part which extends into the fire box, and at the same time to make a secure stay removable at pleasure without difficulty by simply unscrewing the bolt *b*, a matter of much importance in boiler repairs. The use of such a stay enables the boiler to be more thoroughly cleaned by taking them out occasionally at the points where mud or other matter is most likely to collect. It will be seen that the tubular stay above described does not differ so far as it is used for increasing fire surface from the "teats," well known and long used, the improvement consisting only in the mode of putting them in, so as to make them act as a stay.

Locomotive Boilers.—Chapter the second. Sheet No. 2, figures 1, 2, and 3, show a boiler as at present used for locomotives, with certain additions for increasing the fire surface in the fire box. These additions consist in using the tubular stay wherever it is practicable, which has been alluded to in the description of Marine Boiler, and in placing a series of tubes filled with water across the fire box above the fire, and disposed in the manner shown in figures 1, 2, and 3, sheet No. 2. A series of screw plugs opposite each tube will enable them to be cleaned or taken out, if necessary. These tubes may be placed in the intermediate space between the present stays. The ordinary stays may be removed, and the new arrangement of tubular stay used between each of these cross tubes, and at any other parts of the fire box, either above or around the fire, where it may be deemed necessary. This arrangement of cross tubes may be applied, as well as the tubular stay, to any locomotive boiler now in use, thereby increasing the fire surface to a very considerable extent at the part where it is most efficient.

These improvements may also be with equal advantage applied to marine or other boilers, at any parts of the fire box or flues where it would be advisable to increase the fire surface; and it is so intended to apply them to any boilers now in use, or which may be hereafter made, upon the principle now generally in use. Sheet No. 3, figures 1, 2, and 3, show an arrangement somewhat similar to the mode of constructing marine boilers as previously described. In this case also, the external form of locomotive boiler is precisely similar to those generally in use; the variations being in the mode of getting fire surface in the interior of the boiler and fire box. The fire box is again extended forward, as in

the instance of the marine boiler, cylindrical in form, as shown in section figure 3, until it reaches within such distance of the tube sheet at the smoke box, B, as may be deemed most desirable. A series of tubes, D, D, D, D, figures 2 and 4, containing water leading from the back water space, F, figures 2 and 4, to the front water space, E. These tubes are so disposed as to let the flame and combustible gases from the furnace, A, pass between and around them in their journey forward to the end of the internal cylinder, which, after reaching the heat that may still remain unabsorbed, passes out through the tubes, c, c, c, c, figures 2 and 4, which run through the water space, F, F, into the smoke chamber, B, and up the chimney in the direction of the arrows. For the purpose of supporting the tubes, D, D, D, D, it is intended, if necessary, to connect each row vertically as shown in figures 1 and 2, sheet 3, with a small pipe or pipes connected with the water space, surrounding the interior cylinder, thereby adding to the means of circulation, and at the same time supporting the longitudinal tubes. By experiment, it is found that these tubes, D, D, D, D, may in most cases, be made so short that no stay or support will be needed, whilst at the same time, a sufficiency of surface can be brought in contact with the fire to effectually take up all the heat that may be generated. The faint lines in figure 3, sheet 3, show the arrangement of short flues leading through the water space, F, F, figure 2 and 4, into the smoke chamber, B. For sustaining a more perfect combustion of the gases that pass from the fire, holes are made at G, G, G, G, figures 2 and 4, sheet 3, so as to let in at pleasure, a certain amount of pure air, which will become partially heated in being allowed to circulate between the sheet iron jacket and the boiler, before entering the tubes, G, G, G, G, G. Another method for heating the fresh air before entering the cavity of the boiler, and applicable to this boiler, will be hereafter described. Sheet 4 shows an arrangement of locomotive boiler, somewhat different from the one last described; this boiler has the same arrangement of cross tubes in the fire box above the fire, as is described in the specification of boiler, on sheet No. 2, and it is intended to have the tubular stays in the same manner as the boiler just alluded to. It has the middle or waist part of the boiler between the smoke box and fire box made square, with the corners slightly rounded, as shown in section, figure 3, sheet 4. The fire box is extended forward, also of square form, with regular water space surrounding it within; it reaches within a short distance of the tube sheet, at the smoke chamber. Instead of the horizontal tubes filled with water, as in two of the former descriptions, the interior chamber forward of the fire box is filled with vertical tubes containing water so arranged as to allow the flame from the fire to pass in between and amongst them, until it reaches the forward end, when it passes off into the smoke chamber through a series of tubes surrounded with water in the same manner as described in, and shown on, sheet No. 3, fig. 5, in section. The arrangement of vertical tubes, figure 6, sheet 4, shows an arrangement of this boiler, wherein the tubes leading into the smoke chamber are dispensed with, the smoke being carried off through the curved flue, A, into the smoke chamber. If it is required, the square part of the prolonged fire box may be carried entirely into the smoke chamber, and the entire intermediate space filled with the vertical or cros

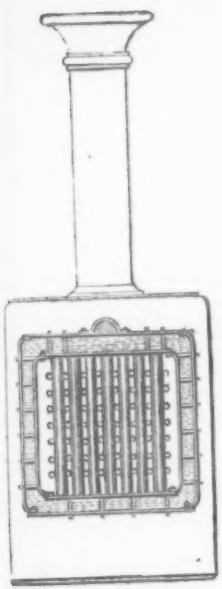


Fig. 3—Sheet IV.

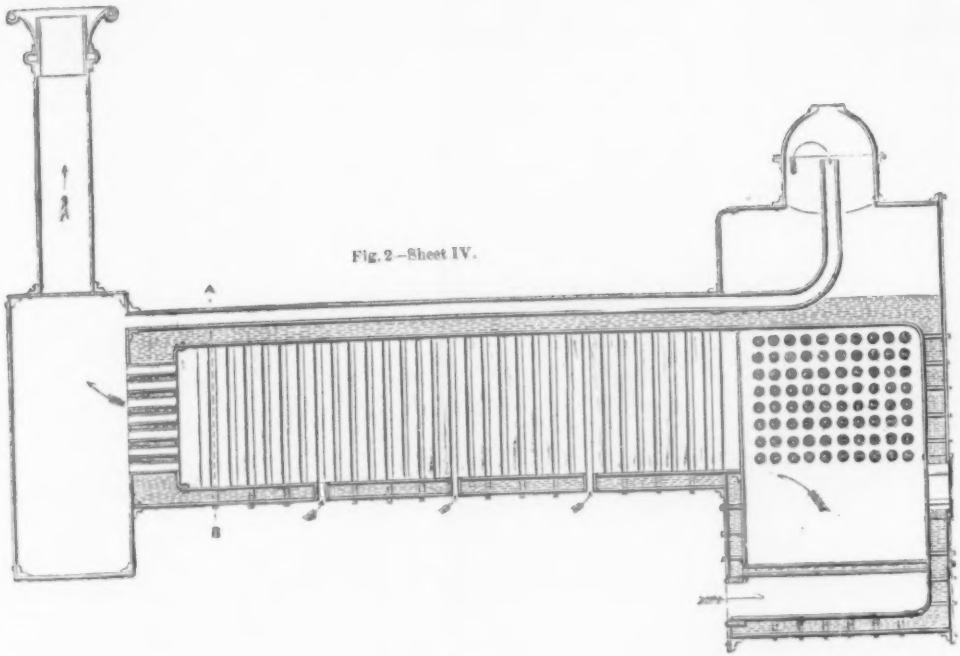
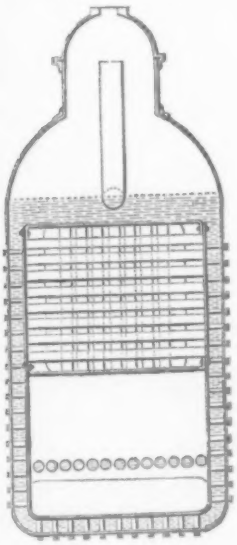


Fig. 2—Sheet IV.

Fig. 1—Sheet IV.



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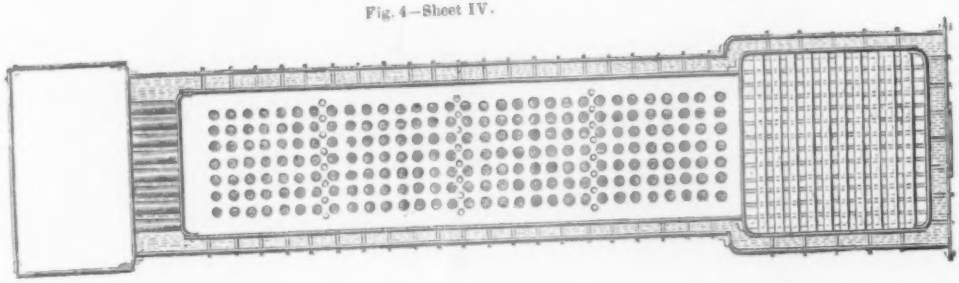

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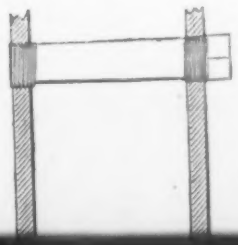

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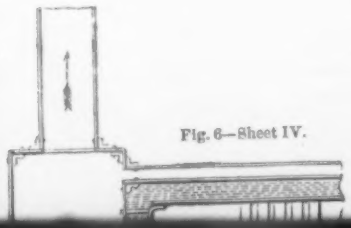


Fig. 4—Sheet VII.

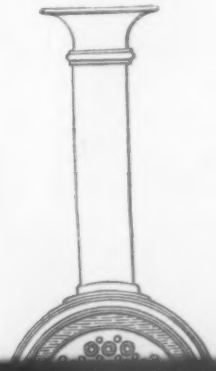


Fig. 3—Sheet VII.

the instance of the marine boiler, cylindrical in form, as shown in section figure 3, until it reaches within such distance of the tube sheet at the smoke box, B, as may be deemed most desirable. A series of tubes, D, D, D, D, figures 2 and 4, containing water leading from the back water space, F, figures 2 and 4, to the front water space, E. These tubes are so disposed as to let the flame and combustible gases from the furnace, A, pass between and around them in their journey forward to the end of the internal cylinder, which, after reaching the heat that may still remain unabsorbed, passes out through the tubes, C, C, C, C, figures 2 and 4, which run through the water space, F, F, into the smoke chamber, B, and up the chimney in the direction of the arrows. For the purpose of supporting the tubes, D, D, D, D, it is intended, if necessary, to connect each row vertically as shown in figures 1 and 2, sheet 3, with a small pipe or pipes connected with the water space, surrounding the interior cylinder, thereby adding to the means of circulation, and at the same time supporting the longitudinal tubes. By experiment, it is found that these tubes, D, D, D, D, may in most cases, be made so short that no stay or support will be needed, whilst at the same time, a sufficiency of surface can be brought in contact with the fire to effectually take up all the heat that may be generated. The faint lines in figure 3, sheet 3, show the arrangement of short flues leading through the water space, F, F, figure 2 and 4, into the smoke chamber, B. For sustaining a more perfect combustion of the gases that pass from the fire, holes are made at G, G, G, G, figures 2 and 4, sheet 3, so as to let in at pleasure, a certain amount of pure air, which will become partially heated in being allowed to circulate between the sheet iron jacket and the boiler, before entering the tubes, G, G, G, G, G. Another method for heating the fresh air before entering the cavity of the boiler, and applicable to this boiler, will be hereafter described. Sheet 4 shows an arrangement of locomotive boiler, somewhat different from the one last described; this boiler has the same arrangement of cross tubes in the fire box above the fire, as is described in the specification of boiler, on sheet No. 2, and it is intended to have the tubular stays in the same manner as the boiler just alluded to. It has the middle or waist part of the boiler between the smoke box and fire box made square, with the corners slightly rounded, as shown in section, figure 3, sheet 4. The fire box is extended forward, also of square form, with regular water space surrounding it within; it reaches within a short distance of the tube sheet, at the smoke chamber. Instead of the horizontal tubes filled with water, as in two of the former descriptions, the interior chamber forward of the fire box is filled with vertical tubes containing water so arranged as to allow the flame from the fire to pass in between and amongst them, until it reaches the forward end, when it passes off into the smoke chamber through a series of tubes surrounded with water in the same manner as described in, and shown on, sheet No. 3, fig. 5, in section. The arrangement of vertical tubes, figure 6, sheet 4, shows an arrangement of this boiler, wherein the tubes leading into the smoke chamber are dispensed with, the smoke being carried off through the curved flue, A, into the smoke chamber. If it is required, the square part of the prolonged fire box may be carried entirely into the smoke chamber, and the entire intermediate space filled with the vertical or cros

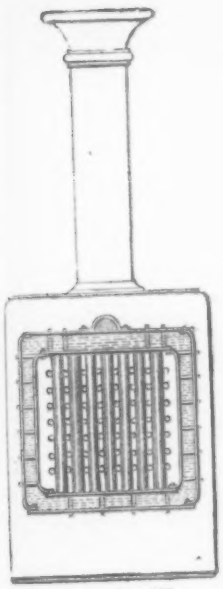


Fig. 3—Sheet IV.

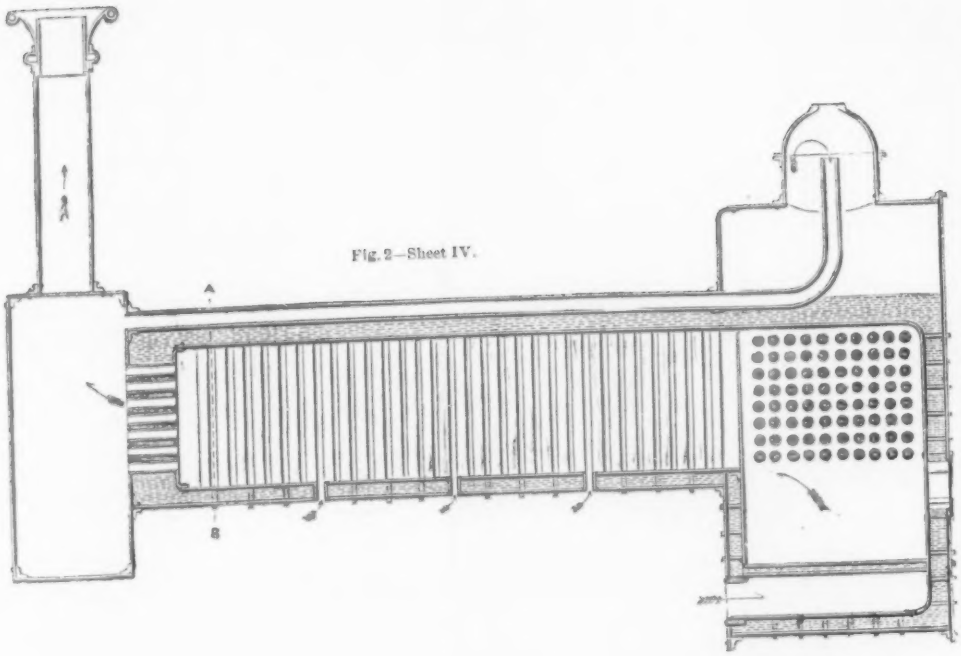
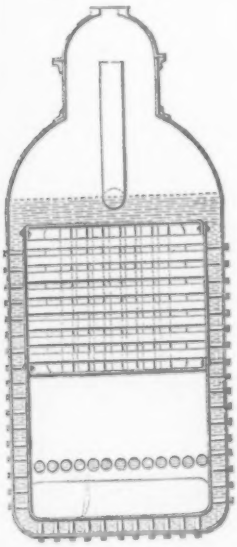


Fig. 2—Sheet IV.

Fig. 1—Sheet IV.



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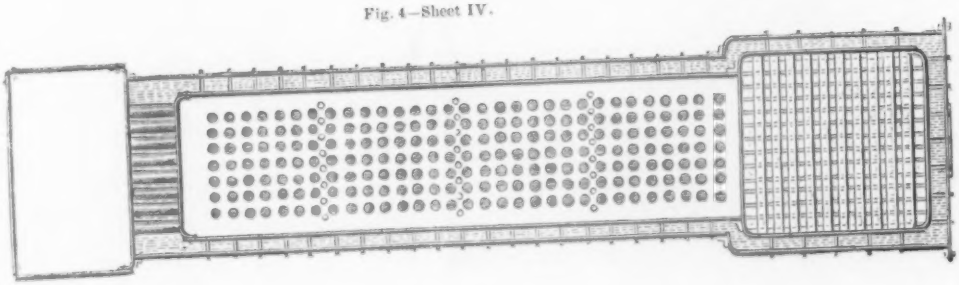


Fig. 4—Sheet VII.

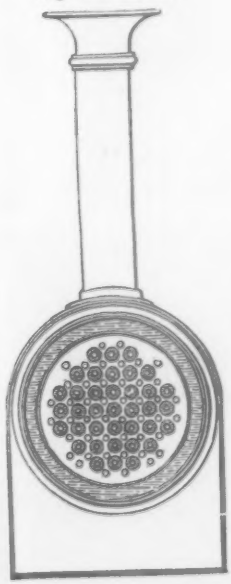


Fig. 3—Sheet VII.

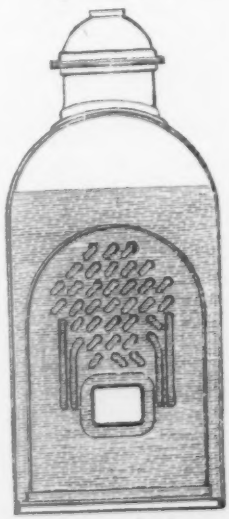


Fig. 7—Sheet IV.

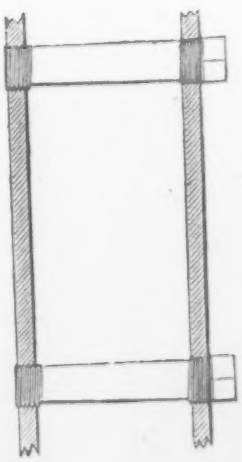
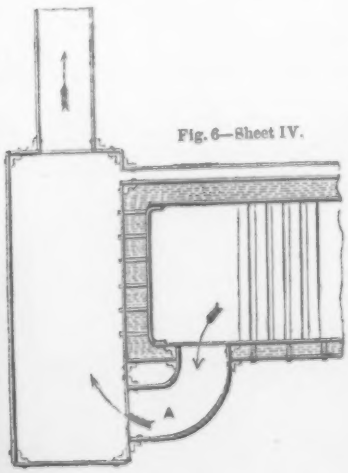


Fig. 6—Sheet IV.



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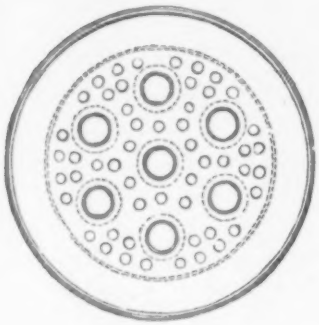


Fig. 3—Sheet V.

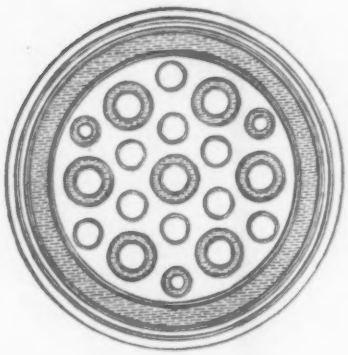


Fig. 1—Sheet V.

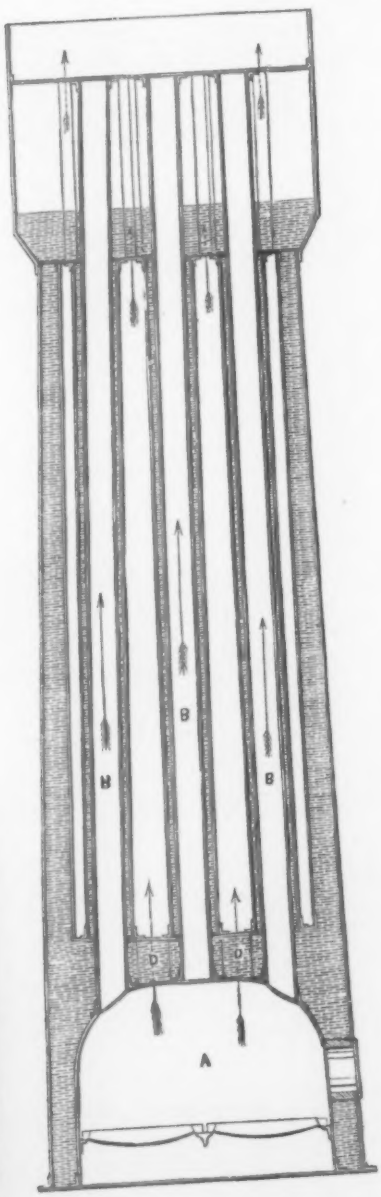


Fig. 3—Sheet IX.

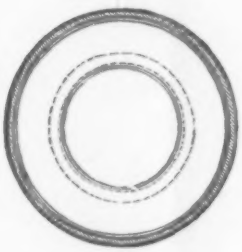


Fig. 2—Sheet IX.

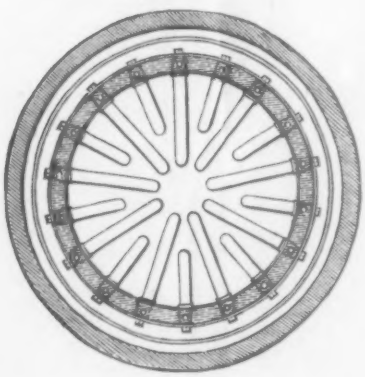
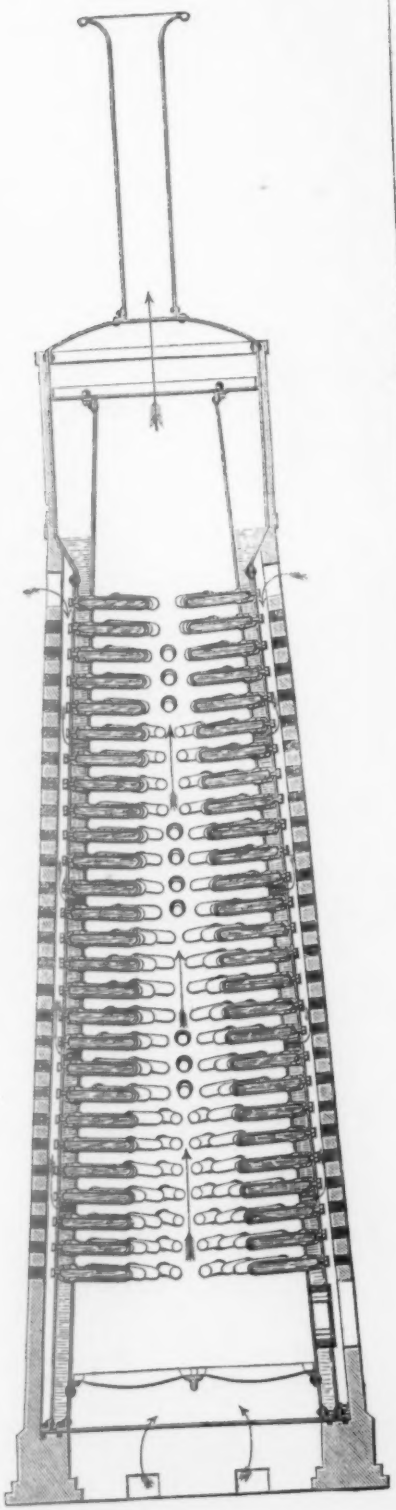


Fig. 1—Sheet IX.



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tubes, thereby dispensing with the short flues leading into the smoke chamber, as well as with the curved flue last described. Figures 1 and 2, sheet 4, shows the lower part of fire box for a locomotive boiler, made like the ordinary marine boiler, thereby dispensing with the usual ash pan, and admitting a simple mode of making a water grate, by introducing tubes lengthwise or crosswise of the fire box, filled with water and connecting the opposite water spaces of the fire box. In this arrangement, it is intended to put the boiler together with screw bolts, that the back fire box may be easily removed, after which, by removing the stays and short tubes in front, the whole interior fire box may be taken out for repairs. Figures 2, 3, and 6, show the same arrangement of steam pipe, as is shown in the drawings for the marine boiler. Sheet 7 shows an arrangement of boiler, suited to the present form of locomotives generally, similar to the arrangement shown on sheet No. 3, with the single difference of passing a portion of the flame or combustible gases through the tubes containing water, by means of the tubes with the bent ends connecting with the back plate of furnace, and leading from thence into the smoke chamber. Sheet 8 shows another modification of the locomotive boiler. In this instance, the fire box is extended into the forward part of the boiler without interruption, until it reaches the smoke chamber, making a clear open space, or single flue, half round at the top, straight sides and bottom, with rounded corners. To obtain the necessary amount of fire surface in this boiler, the whole interior surface is studded at regular intervals, with tubular stays of such length and diameter as may be found most convenient, and so distributed as to bring the greatest amount of surface in contact with the flame or heated vapor, previous to its reaching the smoke chamber. It is intended to put this boiler also together in such a manner with bolts, as will enable it to be taken apart without difficulty, after taking out the tubular stays. Sheet 6, figures 1, 2, 3, 4, and 5, shows a slight modification in the mode of arranging the water pipes in the interior of a locomotive boiler. In this case, the tubes or pipes containing water, are made much larger than in any previously described; and by inspection of the drawing, it will be seen that the mode of attaching the ends of the tubes is slightly different, which, instead of passing from end to end of fire box, are in some cases attached to cross pipes in the fire box, and in others are bent at right angles, and attached to cylindrical part of fire box. Sheet 6, figure 1, shows a mode of putting in the inside flue so as to take the flame at any point of the tube containing water that may be deemed most advisable. A small tube, flattened on one side, is put across the tube containing water, into which the cross tubes are fixed, the smaller flue leading to smoke box. Sheet 6, figure 5, shows an arrangement for introducing atmospheric air into the fire box, and for heating it before it is allowed to mix with the combustible gases evolved from the fire; two or more pipes of cast or wrought iron, or of fire clay if necessary, are placed within the fire box, as shown in section. At figure 4, sheet 6, extending forwards to the tube sheet, fitting closely to the tubes that come opposite to them; pipes are fitted to the tubes leading through the smoke box to the external air, which are furnished with funnel shaped mouths, so that the forward motion of the engine, as well as the vacuum caused by the escape steam,

will cause the air to pass with great velocity through the pipe across the smoke chamber, and through the tubes leading from the smoke chamber to the fire box, and into the tubes placed in the fire box. By passing through these last mentioned tubes, which will be highly heated, the atmospheric air will become also heated, and when mixed with the combustible gases within the fire box will cause a much more perfect combustion of the smoke and gases than could take place without the introduction of fresh atmospheric air. By this arrangement of introducing heated air in connexion with the peculiar form of fire box, whereby more space is given for combustion, and a consequent better mingling of the oxygen with the gases, coal may be burned without inconvenience from smoke, in locomotives, thereby causing great economy in fuel. It is usually intended to make the prolongation of the fire box cylindrical in form, and to prevent it from crushing by external pressure it may be made corrugated, as shown in section, sheet 6, figure 6; by this means, all stays between the inner and outer cylinders may be dispensed with, excepting a few to support the inner cylinder in its place.

Stationary or Chimney Boiler.—This is an arrangement of boiler, as shown in sheet 5, figures 1, 2, and 3, which is intended to accomplish a more perfect combustion of the fuel used, and a consequent consumption of a greater portion of the smoke, and at the same time, to dispense with the very expensive towers now used as chimneys. Figure 2, sheet 5, shows a vertical section of chimney boiler; it is made of circular form throughout, for more facility in making, and for greater strength, although it may be made of any form deemed most advisable. The flame and combustible gases from the fire box or furnace, A, ascend, and in part pass off through the flues, B, seven in number, as shown in figures 1, 2, and 3, and through the three smaller flues, C, figure 3. The remaining portion of flame, &c., pass from the fire through the short flues, D, figure 3, into the upper chamber of boiler, as shown in figure 2, coming in contact in their passage to the top of the boiler with the external surface of the seven vertical tubes, through which the flues, B, pass, as well as in contact with the three vertical tubes through which the flues, C, pass. The flame and gases, after they reach the top of the inner chamber of the boiler, are carried out to the external air through a series of small flues leading from the roof of the interior chamber to the extreme top of the boiler. For a more perfect combustion of the gases in the upper chamber, a series of jets of pure air may be admitted at convenient points through the outer diameter of boiler. It is intended to surround the boiler with a casing, leaving a small space between it and the exterior surface of the boiler. The air being taken from the space just mentioned will be partially heated before entering the boiler, and consequently better adapted for aiding the combustion of the gases which may have passed off from the fire into the upper chamber. At any part of this boiler, either in the fire place or upper chamber, where a stay may be needed for connecting the inner to the outer plate, it is intended to put one of the tubular stays heretofore described, unless there should not be room for the projecting end. Sheet No. 9 shows another modification of the chimney boiler. In this case the boiler has a clear passage to the external air at the top. It is made circular in form for greater strength; the

form, however, not being deemed essential, with an enlargement of the top for steam room. To absorb heat from the flame and gases which pass upward from the fire, the interior of the boiler is studded with tubular stays, so arranged as to bring the greatest amount of fire surface in contact with the flame, previously to its reaching the top of the boiler. This chimney boiler may be made square or oblong in its cross section, in which case the tubular stay may be used for increasing fire surface, or if necessary, the whole interior may be filled with cross tubes filled with water. In like manner, the boiler, if of circular form, may be filled with cross pipes, disposed as may be most convenient for accomplishing the desired end. The chimney boiler is intended to be put together with bolts at bottom, so that the interior may be taken out if necessary, for repairs, or for cleaning interior surface from mud, &c.

In the foregoing description of various forms of boiler, it will be manifest that an effort is made to apply the main portion of heat to the external surface of tubes filled with water, instead of allowing the flame and gases to pass through small tubes, as is now generally used in locomotive as well as marine boilers. It is very obvious that the more the combustible gases evolved by the fire are kept in connexion, the greater the chances of active combustion; whereas, by a very simple experiment, it will be found that combustion cannot be kept up to any great extent in a small tube, say from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches diameter, except for two or three feet after the flame first enters from the fire place. Beyond four or five feet, it is very doubtful whether it is worth while to carry the dead weight of tubes which are now used in the boilers of locomotive engines. By putting water inside the tubes instead of around them, the mass of combustible gases are connected together by being distributed between the tubes, and thereby a better combustion takes place, which may be to a great extent improved by letting in atmospheric air into the fire box above the fire and amongst the tubes in the manner heretofore described in this specification, chapter 2d.

Figures 1 and 2, sheet 4, show a second time the mode of putting on the back sheet of fire box with screw bolts, and planed surface or packed joint, so that it may be taken off at pleasure, by taking out the stay bolts, which give greater facility for repairs and cleaning, whilst at the same time it permits the entire fire box to be taken out as soon as the stays and the series of small flues leading to smoke chamber are removed, whenever these flues are used. Sheet 6, figure 7, shows in red lines, a mode of protecting the upper surfaces of the tubes or other portions of the boiler which contain water, and in which, from the great quantity of steam bubbles which may be thrown against these surfaces, there is danger of the water being driven away from them, causing these portions to be thereby burnt. To remedy this evil, I cause to be placed in the upper portion of each tube containing water, or at any other point where the same difficulty is likely to arise, a thin metal shield, curved in such a manner, and fitting so closely as to intercept a great portion of the ascending steam, and leading it off towards the end of the water tube, or in other portions of the boiler not tubular, away from the points of fire surface, where danger might be apprehended by the water being driven

away. By extending these shields through the entire length of the water tube, and through to the front tube sheet at the smoke box, and by perforating the curved surface of the shield with holes, the steam will be discharged in rapid currents upwards, and between the series of flues leading from the fire box to the smoke box, which current will tend in a great degree to keep the flues just mentioned, from being coated with mud, or other incrustations.

What I claim as my invention in the above described specification, and which I desire to secure by letters patent, is as follows:

Firstly. In extending the fire box into the boiler in the manner hereinbefore in this specification, and by the said drawings, substantially described.

Secondly. In connexion with such extension, the placing in the fire box and extension thereof, a series of horizontal, vertical, or diagonal tubes or pipes containing water, and either using the ordinary flues much shortened, (thereby saving useless weight,) leading from the fire box to the smoke chamber, or not, as may be deemed best, arranging the parts in the manner described, or in any other manner substantially the same as hereinbefore and in the said drawings described.

Thirdly. The using and adapting the "teats," well known to boiler makers, in such manner as to form tubular stays of cast or wrought iron, or any other metal for obtaining fire surface in the fire box, or any other part of a steam boiler, and at the same time making a secure connexion (easily removed) between the inner and outer plates of boiler, as substantially hereinbefore described, and more particularly shown in figure 5, sheet 1.

Fourthly. The applying tubes or pipes of any given diameter, filled with water above the fire in the fire box of locomotive or other boilers now in use, and as they are now generally made, substantially as hereinbefore described, and more particularly shown in drawings on sheet No. 2.

Fifthly. The use of return flues leading through the horizontal water pipes, as described in marine boiler, as well as the inner flues leading through the water tubes of locomotive boiler, to carry off a portion of the gases to the smoke chamber, so as to present a double heating surface to the water contained in the water tubes, whether these flues are made to pass through the whole length of water tube or not, or made so as to receive the gases at any point throughout the whole length of water tube, substantially as hereinbefore described, and more particularly shown in sheet No. 7.

Sixthly. The construction of the chimney boiler, substantially as hereinbefore described in drawings 5 and 9, including the various modes of obtaining fire surface by the use of vertical water pipes with or without inside flues through them, or by filling the interior chamber above the fire, with "teats," serving the double purpose of giving fire surface, and making a secure stay, or with cross pipes, either in connexion with the short flues at top of boiler, or not, described and shown in drawings Nos. 5 and 9, as may be deemed best, and not confining myself to any particular form of boiler or mode of arranging said pipes, flues or tubular

Fig. 1—Sheet VI.

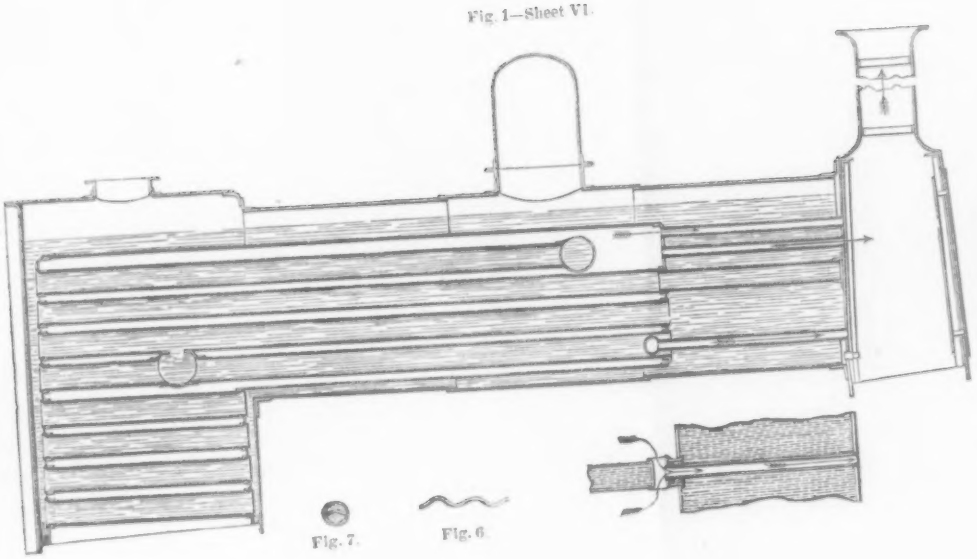

Fig. 2—Sheet VI.

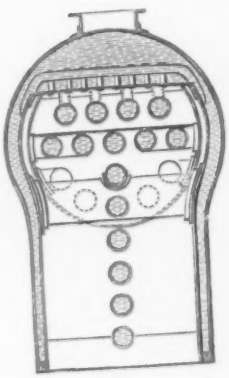

Fig. 7.

Fig. 6.

Fig. 5—Sheet VI.

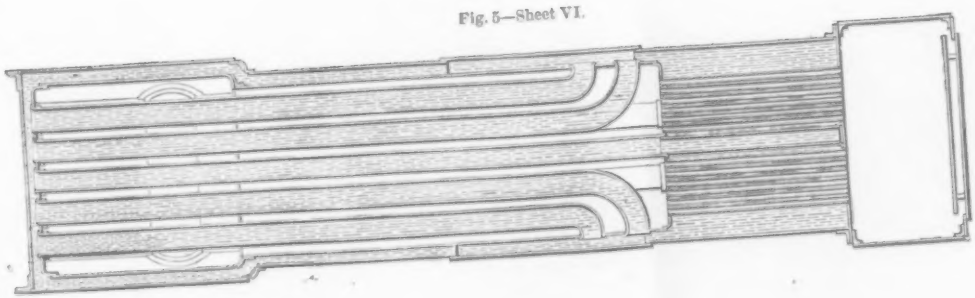

Fig. 3—Sheet VI.

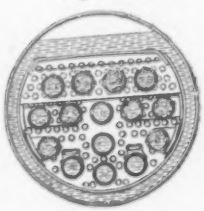

Fig. 4—Sheet VI.

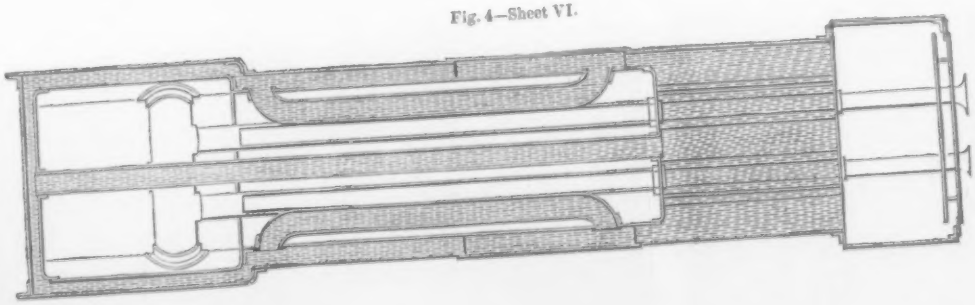

Fig. 8—Sheet VI.

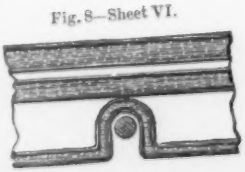

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Fig. 4—Sheet VIII.

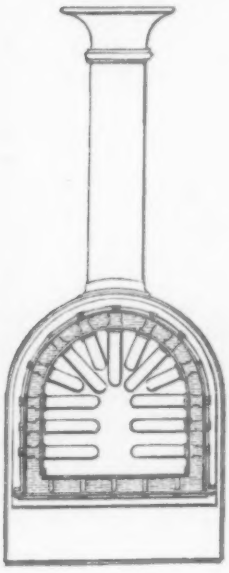


Fig. 1.—Sheet VII.

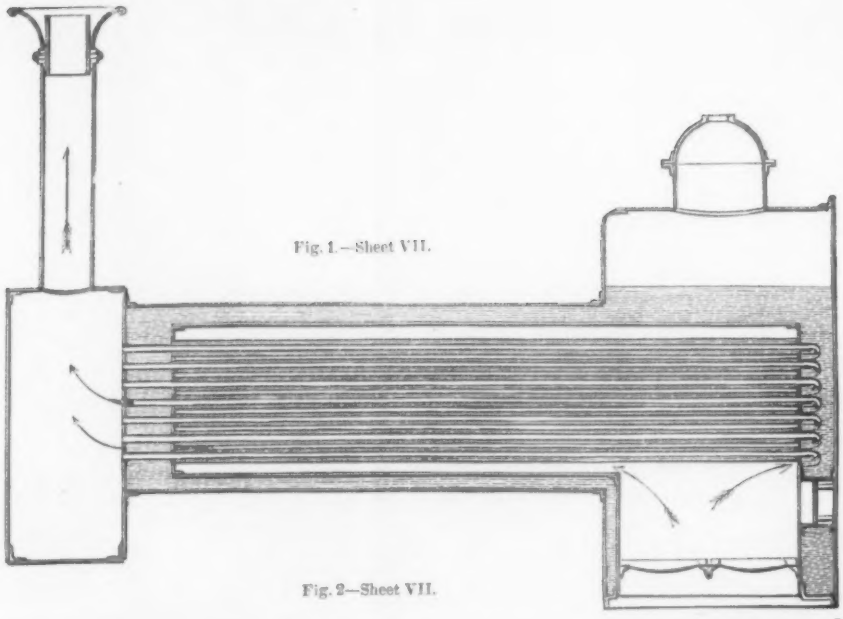


Fig. 2—Sheet VII.

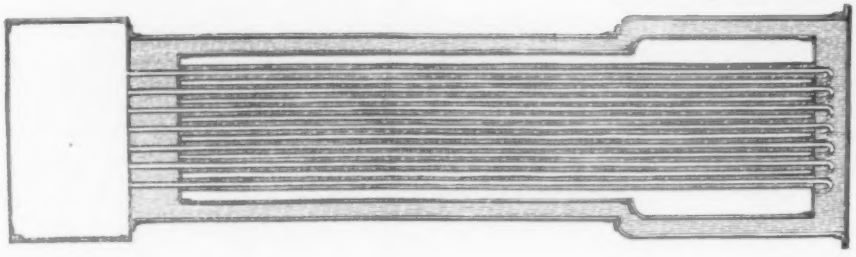


Fig. 3—Sheet VIII.

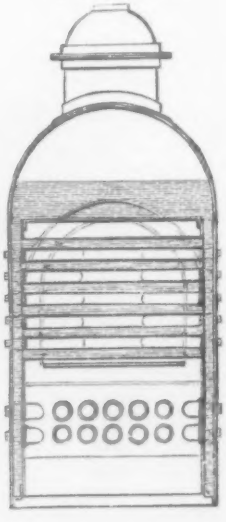


Fig. 1—Sheet VIII.

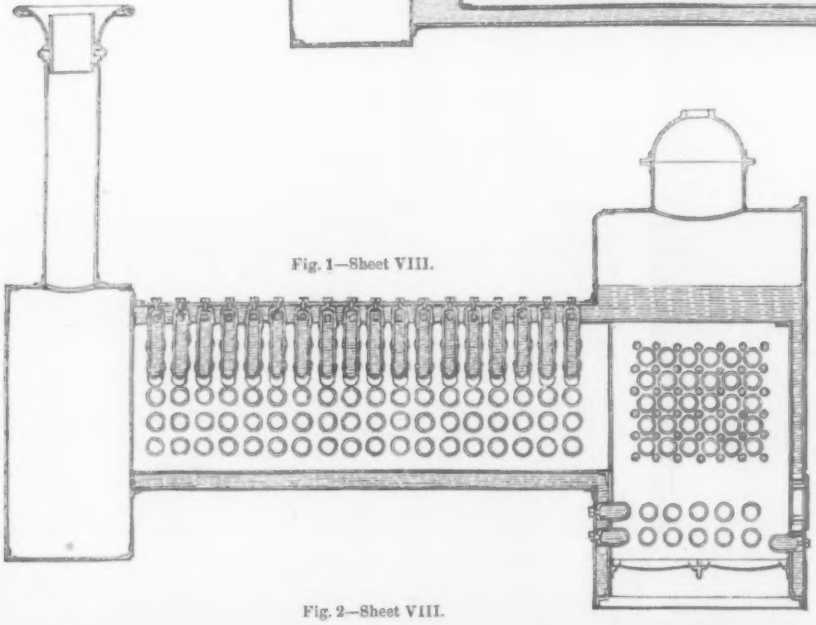
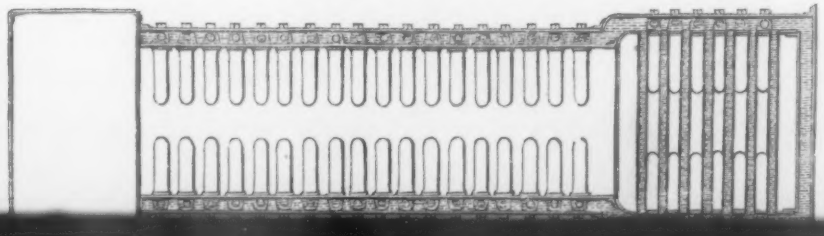


Fig. 2—Sheet VIII.



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stays, so long as the principle is substantially the same as hereinbefore described and shown in drawings, sheets Nos. 1, 2, 3, 4, 5, 6, 7, 8, and 9.

Seventhly. I also claim in connexion with the extension of the fire box into the body of the boiler, the introduction of metal or clay pipes, as shown in sheet 6, figures 4 and 5, and hereinbefore described, for the purpose of heating the fresh supply of atmospheric air that may be introduced into the fire-box, and for distributing this air amongst the combustible gases evolved from the fire, so as to cause a better consumption of the fuel and a consequent consumption of the smoke where coal is used, either in locomotives or stationary engines. I do not mean to confine myself to any particular mode of letting in the air above the fire, nor to any particular mode of arranging the air pipes, which I propose to place in the fire box, so long as the principle remains substantially as hereinbefore described and shown in the said drawings, and although these air heating pipes are only shown in sheet 6; still, I mean to apply them to any and all the boilers described hereinbefore in this specification, or in other forms of boiler, and wherein the same principle can be introduced, and substantially in the manner hereinbefore described.

By forming a locomotive boiler with the prolongated fire box, advantage may be taken to indent the under side of boiler, as shown in sheet 6, figure 8, as to let the axle clear, whilst the centre of gravity of the engine is lowered in a corresponding degree, this being prevented in the usual form of boiler on account of the tubes being in the way of such indentation.

In witness whereof, I, the said Joseph Harrison, have hereunto set my hand this 11th day of February, 1852.

JOSEPH HARRISON.

For the Journal of the Franklin Institute.

Chesapeake and Delaware Canal Wheel for Raising Water.

The elevating wheel put up at Chesapeake City, at the commencement of the past canal season, presents some features worthy of note. It was constructed for the Chesapeake and Delaware Canal Company, by Merrick & Son, of Philadelphia, and was designed to supply water to the canal from Back Creek, (a tributary to the Elk River,) which communicates with Chesapeake Bay. The constructors guaranteed that it should raise 200,000 cubic feet of water per hour, with a consumption of 560 pounds of anthracite coal.

The wheel is 39 feet diameter and 10 feet in width, having iron centres and rims or "shroudings," with wooden arms and buckets (twelve in number), the latter having curved backs, so made as to take up the water easily; the inlet openings are in the periphery, extending entirely across it, and the discharge openings in each side, near the centre of the wheel. Toothed segments, forming spur wheels 39 feet diameter at

pitch line and 11 inches face, $3\frac{1}{4}$ inches pitch, are bolted, one on each rim, and gear into two pinions 4 feet diameter, keyed to the fly wheel shaft of a condensing beam engine, the cylinder of which is 36 inches diameter and 7 feet stroke. At the usual speed of the engine (24 revolutions per minute) the wheel makes $2_{1}^{4}{}_{0}^{6}{}_{0}$ revolutions, and delivers the contents of $29\frac{1}{2}$ buckets. The "dip" of the wheel is maintained at 1 foot 8 inches by gates between the creek and feeding sluice, which are regulated by floats. The height between levels of water in sluice and discharging canal is 17 feet 3 inches. The total height to which the water has to be carried cannot be exactly estimated, from the fact that the buckets do not finish discharging until they pass the vertical centre line of the wheel; it is, however, very near 18 inches more, and may be so assumed, without much error—giving for the total height 18 feet 9 inches. No water goes off in the descending buckets, except that adhering to the sides.

Steam is supplied from four 42-inch boilers, 50 feet long, and is usually cut off at one-fourth the stroke of the piston. Heating surface, 1100 square feet.

The engine and wheel have been in successful operation for about six months, until the canal closed. Prior to its acceptance by the Company, it was tried on the 12th to 17th July, when the work done and coal consumed, with other data, were carefully noted. The following results were obtained on this trial, which lasted $78\frac{1}{2}$ hours:

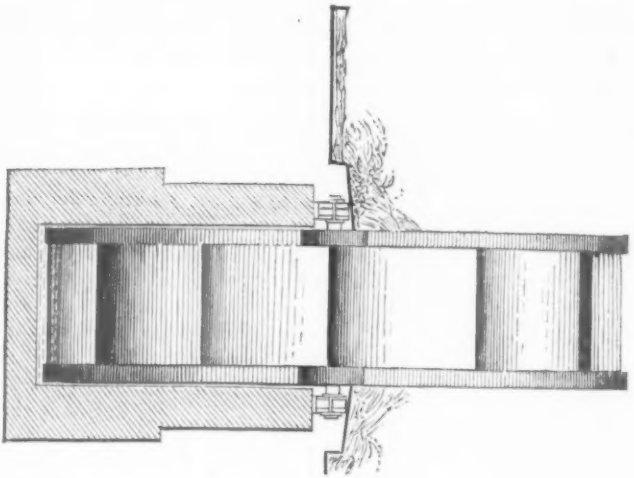
Average pressure of steam in steam chests, $52\frac{1}{2}$ lbs. per square inch; vacuum, 23 inches of mercury; total coal consumed, $21\frac{1}{2}$ tons = 613 lbs. per hour; quantity of water discharged per hour, 227,160 cubic feet, or at the rate of 539 pounds for 200,000 cubic feet; the useful effect produced was therefore $200{,}000 \times 62\frac{1}{2} = 12{,}500{,}000$ pounds raised $17\frac{1}{4}$ feet $= 215{,}625{,}000$ pounds raised 1 foot high by the consumption of 539 pounds fuel, or per pound fuel, 400,046 pounds of water, and per bushel of coal (94 pounds) = 37,604,324, or $37\frac{1}{2}$ millions. The absolute effect produced, assuming the height raised at 18 feet 9 inches, would be

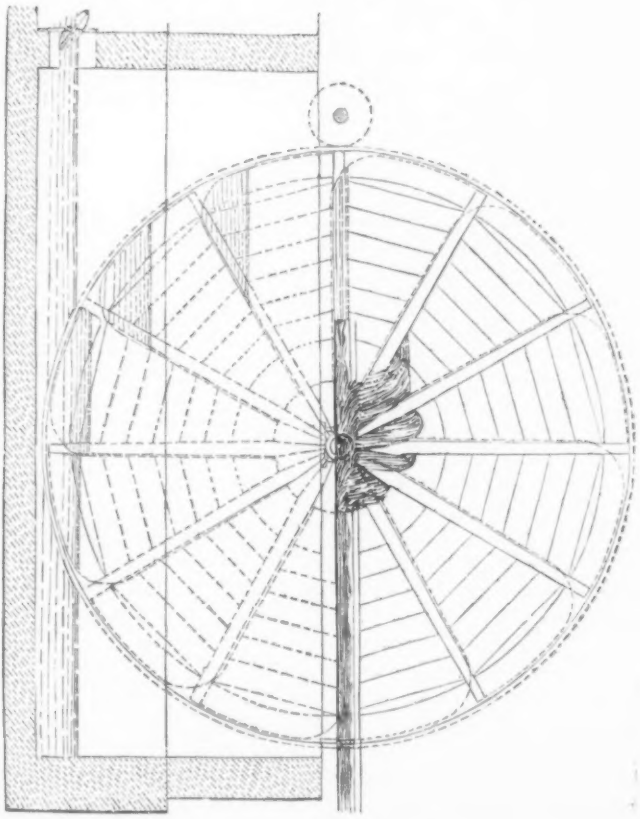
$$\frac{37{,}604{,}324 \times 18{\cdot}75}{17{\cdot}25} = 40{,}707{,}050,$$ or a duty of $40\frac{3}{4}$ millions.

It is intended during the coming season to take indicator cards from the cylinder, while the wheel is in operation, in order to determine the ratio of power and useful effect.

The discharge of water was determined as follows: A distance of 30 feet was measured in the length of the discharging canal, for which distance its width was the same, = 151 inches. At distances of 10 feet, four measurements of depth of current were taken, (making twelve in all,) and their depth averaged, giving a mean depth, the product of which and the width represented the mean cross action. The velocity of the current was determined by repeated trials with a light floating body, and the use of a watch beating quarter seconds. Although not strictly accurate, the result obtained was probably as near the truth as it could be determined without the use of a waste-board.

X.





Railway Accidents; their Cause, and Means of Prevention. By Captain Mark Huish, Assoc. Inst. C. E. Edited by Charles Manby, M. Inst. C. E., Secretary.*

In entering upon the subject of this paper, it is unnecessary to occupy time in demonstrating the fact, that compared with its results, whether as regards the ease and celerity of transit, or the facility of conveying numbers, railway traveling, even in its present state, is incomparably safer than any previously designed system of locomotion.

Contrasting the mere numbers transported from one locality to another, in the present day, by railways, with those conveyed by coaches during their most active period, the ratio of safety is indubitably in favor of the former; while if the difference of speed is imported into the consideration, the value of the immunity from accident, in the case of railways, is considerably enhanced. Even at the present time, when railway traveling has superseded all other modes of inland communication, it is doubtful whether the contingencies attending conveyance by horses in this kingdom, embracing in that category the omnibus traffic, do not annually exceed in amount the casualties on railways, and it has even been asserted, on apparently sufficient data, that the accidents to pedestrians in a given period would still leave railway managers in a position to point with satisfaction to the superiority of their system, on the score of safety.

The attention which has latterly been paid to the statistics of railways, and the periodical publication of the Government returns, direct public attention very pointedly to the aggregate of accident, in a manner which has not been attempted in any other department, and tend to fix a degree of responsibility, and to cast an amount of odium, which have not attached to less prominent and perhaps less useful adaptations of science and discovery. Were the casualties to steamboats as carefully chronicled, and the deaths in mining as elaborately tabulated, or were even the fact of a British vessel being wrecked on each tide throughout the year, as generally known, the public would view more justly the occurrence under the railway system, of those contingencies, which, even under the most perfect management, must ever accompany the arrangements of fallible man; while, however, it is pleaded in behalf of one of the greatest inventions of the nineteenth century, that due regard must be had to comparative results; and while it cannot be denied, that but little consideration has been exhibited, either by the public, or the press, and still less sympathy been shown, during the difficulties under which the railways of Great Britain have struggled into their present position, it is not contended, either that the system has yet attained the degree of perfection and consequent safety of which it is susceptible, or that it has in all cases been administered in the most judicious manner.

Experience is daily adding to the knowledge of the dangers which in an infinite variety of occult forms, necessarily attach to the momentum of high speeds, and this experience is constantly suggesting fresh precautions and means of prevention. To detail as briefly as possible some of the prominent causes of accident, and to explain the measures adopted

* Proc. Inst. Civ. Eng., April 27th, 1852.—London Railway Journal, No. 700.

for securing the safety of the public (the paramount and primary duty of railway management), is the subject of the present paper.

Without further preliminary remark, therefore, the first point of interest is the road, and the contingencies connected with it, embracing the very important subject of the permanent way.

A firm, substantial, and well kept road is undoubtedly the basis of all safety in railway traveling, and with the heavy and increasing traffic now passing over the iron highways of Great Britain, it requires the most incessant vigilance (especially since the speed of the trains has been increased) to maintain the way in the condition which is essential for the safety of the passengers and the economy of the rolling stock. As the intervals between trains become less frequent, as the speed of traveling is accelerated, and as the heavy merchandise traffic, which promises to form, ere long, the most important feature in the receipts of many lines, increases, the repairs become greater, and at the same time more difficult to carry on. It is not intended in these brief remarks, to enter on the very extensive field of "permanent way," especially as it is a subject so familiar to the members of the society, but the experience of the author leads him to the conclusion, that even more attention than has hitherto been given to this fundamental question, must be devoted to it in future, or the theories which have been constructed, and the practice based upon them, will be found to fail. Improvements are continually introduced for the purpose of obtaining a sound continuous road, and there is no doubt that the recognised evils will eventually point out their own remedy. Fishing the rails is now a popular and, as far as partial experience can determine, an efficient mode of strengthening a railway, for the increased traffic it has to bear. Other measures, having the same object in view, are in course of experiment, and stone blocks are generally being rejected in favor of wooden sleepers. Heavier rails, with shorter bearings, are gradually being introduced wherever relaying has become necessary, and engineers are fully sensible that a road constructed to support moderate trains, drawn by light engines at low speeds, is utterly inadequate to endure the crushing effects of monster locomotives at express speeds. The defects of lamination, deflexion, and splitting of the rails are rapidly increasing; whilst transverse fractures (a species of failure almost unknown a few years ago) are now of frequent occurrence; and the difficulty of maintaining the gauge of the line, under the present weights, not only increases, but much of the oscillating motion which is so unpleasant to the traveler, and so destructive to the stock employed, must be attributed to the same cause. Requiring, as railways do, superior rails to bear the increased strain now thrown upon them, it is painful to observe that, instead of keeping pace with the necessities of the case, the rail-makers have allowed their production to deteriorate very greatly; indeed, the utmost caution is now required in the purchase of rails: with every security afforded by name and standing in the trade, the greatest disappointments are daily arising, and the result promises to be very serious, unless instant measures are adopted by the principal makers, to retrieve their characters in this respect. Many of the rails recently supplied have shown symptoms of failure at an unusually early period, and are, in many instances, in a worse condi-

tion, after two or three years' wear, than old and much lighter rails which have been subjected to precisely the same duty for twelve to sixteen years. So grave has the aspect of this matter become, and so general has been the complaint, that one railway Company has come to the determination of rolling its own rails, and has given instructions for erecting works for the purpose. Under all the disadvantages, however, to which allusion has been made, it is, after all, remarkable how very few accidents have arisen from a defective state of the road itself. The circumstance of a train running off the line is very rare, and when such an event does occur, it may generally be attributed to some palpable neglect of the platelayers, to some defect in the machinery, or to some obstructions designedly placed on the line. The latter is unhappily a very fertile source of danger, and one against which, where a morbid desire to inflict injury guides the miscreant hand, it is very difficult indeed to guard. It is little known how frequent, how ingenious, and how varied these attempts have become, and although, from the vigilance exercised, and from fortunate and providential causes, the real damage effected has been far less than could have been supposed, it is lamentable to think, that in addition to the ordinary risks of rapid locomotion, it should be necessary to guard continually against so diabolical a mode of wreaking a petty vengeance, or of gratifying a mischievous disposition. Numerous instances might be given which would excite surprise from the cunning design exhibited, and the care apparently exercised in selecting a spot likely to be fraught with the greatest amount of mischief; but the detail would occupy too much space. One only, and that the latest attempt of this kind, may be mentioned:—A few weeks ago, upon a branch line in Lancashire, the points of an important siding were jammed open, and in order to prevent the signal-man from averting the intended accident, the wire of the auxiliary signal was lashed with a piece of string, and was thus prevented from acting. Happily, however, by a fortuitous circumstance, the villany was discovered a few minutes before the passenger train approached. It has been customary, when such attempts have been made, to offer a considerable reward for the discovery of the perpetrators. It is questionable, however, whether setting a patient watch, and establishing a careful inquiry throughout the neighborhood, are not more effectual means of tracing the culprit. Considerable success has certainly attended this course, while there is, it is believed, no instance of a voluntary statement for the purpose of securing the reward. The punishment for this class of offences has recently been made more severe, and although it is not to be expected that they should altogether cease, it is hoped that they may become less frequent.

The alternations of weather in a climate so variable as England, have a material influence on the permanent way, and on any great and sudden change, either to heavy rain, after lengthened drought, or to a rapid thaw, after continued frost, increased watchfulness is necessary on the part of the upholders of the road, and the engine-drivers and guards. It is at such periods that the weak points in a road show themselves; a sudden relaxation of the line seems at once to take place, and unless counteracted by vigilant attention, great danger must result.

The rapid development of general traffic on all the main arterial lines

in the kingdom, and the transfer to them of much of the heavy trade which was formerly carried on by canals, have caused a very great extension of siding accommodation, and this, by multiplying the points and crossings in the main line, has *pro tanto* increased the risk attending them. Anything which breaks the continuity of the rails is necessarily an evil, and tends in a certain degree to develop danger; and as these frequent "turns out" cannot be avoided on a line of heavy traffic, the railway manager is compelled to rely on regulations and signals, and to that extent is obliged to incur the additional hazard which attends the employment of officials, from whose neglect, or want of discretion, the most fatal consequences may at any moment arise. On the London and North Western Railway, the increase of siding, during the last few years, amounts to 53 miles. In laying down these sidings, one very fertile source of danger has, however, been considerably reduced. "Facing points" were formerly common and numerous, they are now rarer, and although at the junctions of branches, and in some peculiar positions, they cannot be altogether abolished, no railway manager will rest contented while one of these points is allowed, unnecessarily, to remain upon his line.

In connexion with this subject, allusion may be made to self-acting switches. Useful as this invention has proved, it has been attended with concomitant evils of no trifling magnitude, and many accidents have occurred from a reliance upon them. They require constant vigilance to secure their being kept clean and well oiled, and it is very difficult to insure proper attention being always paid to them. It may indeed be remarked, as a general rule, that so far from machinery being a means of safety (when used for superseding personal inspection and manipulation), it is usually a source of increased danger, and the numerous clever contrivances and complicated arrangements which are so continually submitted to the examination and opinion of railway men, though evidencing the ingenuity and industry of the projectors, are generally valueless as practical means of operation. The greatest simplicity in every thing connected with the road and the signals upon it will provide the nearest approach to security, and in proportion as such simplicity is departed from, it is probable that a practical good will be sacrificed, in endeavoring to attain a theoretic excellence. In concluding this branch of the subject, it may be repeated, that fewer accidents to life and property arise from the road than from any other cause, and were casualties confined to those attributable to "the way," the annals of railway accidents would be scanty in the extreme.

The next question of interest is the "locomotive"—that extraordinary invention, which has already changed and ameliorated the whole surface of society, and which is destined to work still greater revolutions in the social fabric of the world. The increased power and capacity, the more perfect finish of the various working parts of the engine, and the general improvements in form and proportions, which have been gradually introduced, have rendered far less frequent than heretofore, those delays and irregularities which are always attended with inconvenience, if not with danger; yet it would be too much to expect immunity from casualties to so elaborate and so severely tested a machine, and though the

parts have been greatly strengthened in every respect, the improvement does not appear to more than meet the greater demands on its powers, in consequence of the increased loads and speeds which are now adopted.

The variety of mishaps to which a locomotive is liable will be seen from the following table, containing the causes of one thousand failures on the London and North Western Railway.

This return spreads over a lengthened period, comprises every description of defect, and is given for the purpose of proportion only.

ANALYSIS *of* 1000 *cases of engine failures and defects, occurring on the London and North Western and subsidiary Railways.*

STOCK OF ENGINES, 587.

157	Burst and leaky tubes.
92	Broken springs.
89	Broken valve-spindles.
77	Broken and defective pumps.
48	Broken feed pipes.
40	Broken piston rods and pistons.
31	Broken and damaged valves and valvular apparatus.
31	Lost and broken bolts and pins, (various.)
31	Fire bars burnt out.
31	Lost and broken cotters, (various.)
29	Plugs and joints blown out.
25	Broken and lost eccentric straps.
21	Broken wheels and tyres.
21	Broken and bent coupling and connecting rods.
17	Broken sponge boxes.
17	Broken and bent eccentric rods.
17	Broken crank pipes.
15	Broken and shifted eccentric shafts.
15	Broken coupling and draw bars.
13	Broken crank and other axles.
13	Broken eccentric straps and bolts.
13	Broken and damaged steam and suction pipes.
13	Broken and defective reversing levers.
11	Broken connecting rod straps.
11	Broken middle bearings.
9	Broken spring bearings, screws and buckles.
8	Broken lifting links.
904	Carried forward.
904	Brought forward.
7	Broken blow-off and other cocks.
6	Broken quadrant studs.
6	Lost and loose regulator spindles.
6	Broken gibs.
5	Broken stay in fire boxes.
5	Detached ash-pans.
3	Smoke box and chimney end on fire.
3	Broken brackets of weigh bar shafts.
3	Feed pipes stopped up, dropped fire.
3	Broken spring balances.
3	Broken slide blocks.
3	Broken crank rods.
3	Tubes drawn in (Chimney end.)
3	Broken axle boxes.
3	Broken slide valves.
3	Broken right hand bearings.
3	Broken glands.
3	Defective hose pipes.
3	Broken piston rings.
2	Broken brakes.
2	Lost quadrant washers.
2	Broken goss head spindles.
2	Mud-hole doors defective.
2	Broken weigh bars shafts.
2	Broken brasses of driving journals.
2	Broken studs of link motion.
2	Broken catches of fire bars.
2	Broken glass tubes.
1	Nut off tender draw-bar.
1	Broken tender eye bolt.
1	Defective whistle.
1	Boiler burst.
1000	Gross total.

It would be interesting to know how far this return coincides with the results on other railways, because, were somewhat similar ratios evolved, the knowledge of the proportions would direct the special attention of locomotive superintendents to the necessity of guarding more particularly against casualties of most frequent occurrence. It will be observed that burst and leaky tubes nearly double any other class of failure, and that these with broken springs and broken valves amount to one-third of the entire number. Very few, indeed, of the above failures are attended with any direct danger to the public, but as producing a temporary, or permanent inability of the engine to carry on its train, may be the remote cause of collision.

The carriage stock of railway Companies is generally of so superior a kind, both as to design and construction, that accidents arising from their failure are very rare. The wheels and axle-boxes are the most severely tested parts of the vehicle, but if originally of a proper construction, give very little trouble in their maintenance and repair. Experience seems to give the superiority to the wooden wheels, of which there are many kinds in use. A spring sometimes breaks, and a tyre occasionally fails, in which case the wheel is in danger of flying to pieces, but the instances are so unfrequent, that they are not sources of much anxiety to a railway manager. Defective workmanship, where either the carriage, or the principal parts of it, are supplied by contract, has specially to be guarded against; where these are sound and the carriage is daily examined, it may be relied on for a very long period. During the last four years, only six wheels have failed, in the very large stock of the London and North Western Company. The heating of axles, however, is a source of frequent annoyance and alarm to passengers. Since the bearings were increased in size, and more care has been exercised to make the cover fit close, and to preserve the grease free from dust, when not in use, this cause of trouble has diminished, and the recent introduction of the patent axle-box, which, under proper management, will run many hundreds of miles without being fed, bids fair to obviate the evil to a considerable extent, if not to prevent it altogether; still, on a hot summer's day, in a district with sandy ballast, it is, and will always be, very difficult to keep the axles of a fast train cool. The couplings of carriages are seldom broken, even by sudden jerks.

There is, perhaps, no more alarming occurrence than a fire in a passenger train. Still, however, there has not been an instance in this country of any loss of life from this cause, nor have the cases been numerous; but there have been several narrow escapes, and the accident is one to which a train may be at any instant subject from the escape of heated coke. Spontaneous combustion has also in more than one instance nearly produced a serious conflagration. This has arisen from the incautious introduction of lucifer matches, or similar combustibles, among the luggage of the passengers. The occurrence of fire, and the feeling of insecurity which attaches to the passenger, from a feeling of inability to stop the train, if desired, from any other cause, is continually reproducing a multitude of schemes for communicating between the passenger and the guard, and the guard and the driver. These have assumed a multiplicity of forms, yet the principle is generally identical, viz: a connexion by wire, or rope, between the engine and the guard's van. Simple and inexpensive as this contrivance is, it fails in practice, and after being adopted more than once, has again been laid aside. The whole of the trains of a northern Company were some time back fitted with the means, by a flexible jointed tube, of communicating with the driver, but it has not been considered a successful attempt to overcome the difficulty. The same may be said of the numerous contrivances for arresting the passage of a train, by the instantaneous application of a number of powerful brakes, (some of the inventions applying the brake to the road itself;) of the proposals to work signals by means of the engine striking certain levers as it passes; and hundreds of similar suggestions. Among the

inventions transmitted to the author, and for most of which compensation was claimed, one proposed to arrange a set of signals, which were to be successively struck down by the chimney of the engine; and another, in order to stop a train in the shortest space, gravely proposed that a large anchor attached to a stout cable, should be thrown out of the stern! Perhaps the most feasible and favorite plan for giving confidence to passengers, has been to continue the foot-boards of carriages, so as to form a continuous narrow platform, with a brass rod attached to the panel of the carriages; by this means a passenger might escape and pass safely along to the guard's van, or to the engine. The plan was suggested to and recommended by the Railway Commissioners. A committee, of the most experienced railway officers, was appointed by the clearing-house to consider it; they have done so, and their report, founded on returns and reasonings, which appear unanswerable, is the unanimous condemnation of the measure. We are thus apparently as far off as ever from gratifying the public demand for instant communication between the passenger and the guard, and it is possible that no better plan will be discovered, than that now in use on the London and North Western line. It is as follows:—The guard's van at the rear of the train, projects more than a foot beyond the carriage on either side. In this projection a glass window is fitted, the guard's covered seat being opposite to it. He is thus enabled to see the entire length of the train, and can scarcely fail to observe a hand, or a handkerchief, if waved from a window. This contrivance is evidently unavailing at night, unless a spare light were by some means placed at the disposal of the passenger. At present, however, it only to some extent meets an evil, for which no more practical and complete cure has yet been provided. The almost universal practice of leaving the doors at one side unlocked, is a source of not unfrequent accident; yet so distasteful in public opinion is a locked door, that only one Company has ventured to adopt it as a rule. The reckless conduct of many habitual travelers may yet possibly force it as a regulation on others, especially if juries continue to inflict severe punishment on Companies, even when the fault is primarily with the passenger himself.

If, however, there is no part of the railway machinery from which so little danger may be apprehended as the passenger carriage, the same cannot be claimed on the part of the merchandise wagon. Whether the absence of direct danger to human life, or an injudicious economy, has been the cause, the fact is, that in no portion of the system has so little improvement been exhibited, and in which, at the present moment, there is so great a necessity for a complete modification. In this respect England is far behind the Continent. The axles of wagon stock have, in many instances, been of the most faulty model and material. The accidents to the trains, from the fracture of these parts, have been very numerous, while the destruction of property has been sufficient to have paid for a very superior vehicle. In one recent instance, several hundred axles, of a peculiar form, were removed from a leading railway, after a short experience of their working. Axles are now made much stronger than formerly; 3½ inches used to be the ordinary diameter, 4 inches is now considered a minimum, and although more attention has been bestowed on the form and taper of the axle itself, still very much remains

to be done in this matter. The fact of the crystallization of the iron by the repeated vibrations, and the peculiar causes of incipient fractures, are still debatable points with engineers and wagon builders. It is desirable that by a thorough examination of the subject, these disputed questions should be disposed of. The wrought iron wheels of merchandise wagons do not on the whole give much trouble. The most defective part of the wagon is, however, the mode of coupling. This is of the rudest kind, and it is matter of surprise that a vigorous and combined effort has not been made by the railway interest to improve it. Very few merchandise wagons have spring buffers, and even those that have them, are simply linked together by a loose chain. Every one must have noticed the bumping sound produced in the starting and stopping of a merchandise train. Even where the driver is very careful, the succession of heavy blows in a long train is sufficient to injure the stock, and to break any delicate articles that may be conveyed in the trucks; but when it becomes necessary to arrest a train suddenly, the shocks are very destructive to the framework. This evil, great as it is, is aggravated by the circumstance of a variety of wagons being run in the same train; a light and short wagon is probably found between two long and heavy ones, and the irregularity of loading, according to the staple trade of a particular district, still further increases the risk. From the through system of traffic, the wagons of half a dozen Companies may frequently be found in one train, and as these are not built to any particular height or breadth, the ends do not strike evenly, and on receiving a check, a tendency to mount (especially if the wagon is unevenly loaded, which must always be the case with some description of goods) is apparent. Covered vans, low timber trucks, and box-wagons, are all run together, in trains of from 30 to 60 vehicles, and at speeds varying from 15 miles to 20 miles an hour. It is, in fact, a wonder that a traffic so conducted is not subject to continual accident, and the circumstance of the comparative freedom from casualty is rather an evidence of the extreme safety of transit over parallel iron bars, than any defence of a system which is no credit to the mechanical skill of the country. Until every wagon is coupled up to spring buffers, in the same manner as a passenger carriage, and until either by general concert, or by compulsory regulation, the standard central height, and central breadth between the buffers, are matter of regulation, the risk of accident and the certainty of damage must continue. The author succeeded, some years ago, in obtaining, through the medium of the railway board, a general concurrence on the subject of the buffers of passenger carriages, but no measures have yet been effectual as regards merchandise vehicles.

Fires in merchandise trains are of frequent occurrence, and from the susceptibility of the tarpaulin covering to ignite, and the presence of straw in the loading, considerable danger must always exist. This fact and the damage which fine goods receive from wet, have caused the introduction of covered wagons. The use of these wagons is now greatly increasing, and for all goods capable of being closely packed, they bid fair to entirely supersede the open truck and tarpaulin. The first cost is greater, but the repairs of the sheets, in three or four years, will fully compensate for the difference.

(To be Continued.)

AMERICAN PATENTS.

List of American Patents which issued from Dec. 14th to Jan. 4th, 1852, (inclusive,) with Exemplifications by CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

DECEMBER 14TH.

24. For an *Improvement in Lining for Iron Safes, &c.;* Wm. P. Blake, City of New York.

"My invention consists in applying the protoxide of zinc, in its finely divided amorphous condition, as a filling or "packing" around or within the walls of iron safes, refrigerators, steam pipes, steam chambers, locomotive boilers, hot-air flues, and chambers."

Claim.—"What I claim as my invention is, the application of amorphous zinc oxide as a lining for safes and refrigerators, and as a covering for steam pipes, steam chambers, locomotive boilers, hot-air flues and chambers, in such manner as to prevent the transmission or conduction of caloric into or from such chambers or flues."

25. For an *Improvement in Trip Hammers;* Jas. C. Forrest and Geo. Baker, Schenectady, New York.

Claim.—"What we claim as our invention is, the employment of the peculiar shaped movable tappets of different sizes—the said tappets being arranged loosely on the driving shaft, and moved back and forth—or one substituted for the other by means of the lever, in combination with the hammer, having a rectangular, notched or peculiarly formed slot cut in it, the whole being constructed, arranged, and operated in the manner and for the purpose herein described.

"We likewise claim so arranging the lever that when the large or small "tappets" are moved from one position to the other, or the small tappet made to occupy the place of the large one, the controlling spring will also be operated upon and made to assume a proper position to suit the size of the "tappet"—the arrangement for effecting this object consisting of a hook-shaped shifter and movable collar, which are constructed, arranged, and operated in the manner substantially as herein set forth."

26. For an *Improvement in Field Rollers for cutting Stalks and Weeds;* Joseph H. Gest, of Batavia, Ohio.

"The nature of my invention consists in the employment or use of a series of knives, either of straight or spiral form—said knives being placed upon a suitable roller, and the roller placed within a proper frame, and attaching to the front part of the frame pins, which will be hereafter described—the pins being for the purpose of bringing the stalks within the range of the knives; forks attached to the tongue also effect the same purpose."

Claim.—"Having described the nature and operation of my invention, what I claim as new is, the employment or use of the knife-roller—said knives being either of straight or spiral form, in combination with the pins and fork; the knives, as the machine moves along, cutting the stalks from the roots, and also the stalks into pieces while lying upon the ground, and the pins and prongs of the fork drawing the stalks within range of the knives, as herein specified."

27. For an *Improvement in the Manufacture of Ball Castors;* Robert Hinton, Roxbury, Massachusetts.

Claim.—"I claim the improvement in making the case of the ball castor, viz: of a combination of two halves or parts, the curved lip and the ring, as constructed and applied together, and to the leg or socket ferrule thereof, substantially in manner and for the purpose as above set forth."

28. For an *Improvement in Stone Picks;* John U. Houston, Conway, Massachusetts.

"The nature of my invention consists in providing the inner side of the hammer of the pick with a guard, which guard will intercept the chips of stone, and protect the hand."

Claim.—"What I claim as my invention is, the addition of a guard to the inner side of the hammer of mill-stone picks, which guard will intercept the chips of stone, and protect the hand and person of the picker, using for that purpose the metallic guard above

described, or any other substantially the same, and which will accomplish the same result. I do not claim as my invention, the mode of constructing the pick as described, in other respects than as pertains to the guard."

29. For an *Improvement in Buckets for Endless Chain Pumps;* Clark Polley, Mays Landing, New Jersey.

Claim.—"What I claim as my invention is, the globular elastic and adjustable bucket for chain pumps, constructed substantially in the manner and for the purpose herein set forth."

30. For an *Improvement in Apparatus for Treatment of Fractures;* Zimri Hussey, Chilicothe, Ohio.

"This invention consists in certain improvements in and certain appendages to be applied to the apparatus known as the double inclined plane, for the purpose of making a more perfect instrument, which I term the Perfect Adjuster.

"It also consists in the attachment of a seat-piece, with certain braces and other appendages, to a pair of double inclined planes or perfect adjusters, for the purpose of rendering additional aid in the adjustment or reduction of the most difficult cases of fracture or luxation of the lower limbs, where both or only one are injured."

Claim.—"Having described my invention, what I claim are, 1st, The hip-brace of semi-circular, or nearly semi-circular form, and the strap passing over it and around the limb, the said strap and brace operating as and for the purpose substantially as set forth. 2d, The knee fork attached either to the upper part or lower part of the double inclined plane, for the purpose of attaching a band, which clasps the limb, to effect extension or counter-extension at the knee, as herein explained. 3d, The application of the adjustable braces to the crests of the ilium, substantially as and for the purpose described, the said braces being attached to a seat-piece or its equivalent. 4th, The seat in combination with an adjustable back-piece attached to two double inclined planes, substantially as herein described, for the purpose of moving the cripple without changing the adjustment of the splints, for the purpose set forth."

31. For an *Improvement in Seed Planters;* Henry Nycum, Uniontown, Pa.

Claim.—"What I claim as my improvements are, 1st, The construction of the compound grain slide as described, by which the amount of grain required to be sown, is graduated at pleasure, as herein fully set forth. 2d, The *mitre bar*, constructed so as described, to *raise* the apparatus for lifting the drill teeth and throwing the slides out of gear completely out of the way of the operator, thus allowing him to get at the drill teeth, for the purpose of clearing them of obstructions, with a facility altogether unknown in machines constructed with a horizontal bar in the rear."

32. For an *Improvement in Scythe Snaths;* Abram Charles and Charles N. Clow, Port Byron, New York.

"The nature of our invention consists, first, in constructing the snath of metal in the tubular form, for the purpose of securing great durability, and facility of shaping it as desired, while it retains the required lightness and strength; and secondly, in the manner of adjusting the nebs on the snath, as hereinafter fully set forth."

Claim.—"What we claim as our invention as a new manufacture is, a scythe or cradle snath, composed of a wrought metal tube, which possesses the advantages of great durability and facility of being bent into any desired form, without increasing its ordinary weight, or impairing its usual strength and firmness.

"We also claim the longitudinal rib, or its equivalent, on the snath, in combination with a series of notches in the ring of the neb, for the purpose of adjusting the nebs securely upon the snath, substantially as herein set forth."

33. For an *Improvement in Straw Cutters;* Joel Dawson, Barnesville, Ohio.

Claim.—"What I claim as my invention is, in combination with the rake and spring, the pressure piece and the roller, constructed and arranged in the manner and for the purpose as hereinbefore set forth."

34. For *Improvements in Machinery for Forging Metals, &c.;* Wm. Field, Providence, Rhode Island; ante-dated June 14, 1852.

"My invention and improvement consists in forging a piece of properly heated metal into shape, by subjecting it to the action of a pair of traversing rollers, which run against

pattern guides, the counterpart in shape of the longitudinal outline of the thing to be forged, the metal itself being supported between the rollers by a mandrel and turned on its axis, to present different sides of the piece in succession to the action of the rollers whenever this is required."

Claim.—"Having described my machine for forging metals, what I claim therein specifically, is, First, The mandrel, or its equivalent, for chucking or griping the metal to be forged, and holding the same in the proper position, and, from time to time, changing its position between the reciprocating rollers, in combination with reciprocating rollers for shaping the metal so held, whose action upon the metal is regulated by a pattern guide, substantially as herein set forth. Second, The method of regulating the thickness and shape of the metal being forged, without stopping the rollers or withdrawing the metal therefrom, by the simultaneous adjustment of the pattern guides, substantially as herein described."

35. For an *Improvement in Apparatus for the Cure of Club Feet;* Zimri Hussey, Chilicothe, Ohio.

Claim.—"Having described the nature, construction, and operation of my invention, what I claim is, the side pieces, to which are attached the adjustable foot pieces, connected and adjustable to each other, in the manner substantially as described, by the back piece, plates, bolts, and slots.

36. For an *Improvement in Plough Regulators;* Harvey Sprague, Riga, New York.

Claim.—"What I claim as my invention is, the combination of the arms with the connecting and regulating bar, the arms and the connecting bar forming an arch, and working on an axle which passes through the beam, in the manner and for the purpose substantially as herein described and set forth."

37. For an *Improvement in Spike Machines;* Philip P. Trayser, Baltimore, Maryland.

Claim.—"I wish it to be understood that I do not confine myself to any particular form or arrangement of the several parts of the machine I have just described, provided the spike is headed and pointed by the mode of operation I have described; as a great number of changes may be introduced into the machine, that will not in any way affect the principle upon which it works; indeed, the improvements which I have made could be introduced with advantage, either separately or together, into various machines now in use.

"What I claim as my invention is, the combination of the hinged pointing die, pressed forward by a spring with the guard or stop, or the equivalent thereof, which guides the die and limits its forward movement, substantially as herein set forth."

38. For an *Improvement in Seed Planters;* Moses D. Wells, Morgantown, Virginia.

Claim.—"Having explained my improvement, what I claim as new, and as my own invention, is, the reciprocating bar, having wings projecting horizontally on the front and rear sides of the same, to scoop the seeds in the discharge apertures—arranged and operating in the manner and for the purpose above specified."

39. For an *Improvement in Grain and Grass Harvesters;* William H. Seymour, Assignor to W. H. Seymour and Daton S. Morgan, Brockport, New York; ante-dated October 25, 1852.

Claim.—"Having described my improved harvesting machine, what I claim as my invention is, the method herein described, of supporting the stand for the raker at the back of the platform, by means of a brace extending to the outer end of the frame, and so arranged as not to impede the action of the raker, or the discharge of the cut grain, the several parts being constructed and arranged as described.

"I also claim the method herein described, of protecting the gearing of the machine from injury by the working and twisting of the main frame, by mounting the said gearing in a supplementary metallic frame, constructed as described, and rigidly connected to one end of the main frame upon which it is mounted, as herein set forth."

40. *For Mechanism for Pointing and Threading Screw Blanks in the same Machine;* Culley Whipple, Assignor to the New England Screw Company, Providence, Rhode Island; ante-dated October 16, 1852.

Claim.—"I desire it to be understood that I do not here claim the broad idea of pointing and chasing the blank in the same machine by different cutters, irrespective of the mechanism employed for the purpose, as I have made such a claim in another specifica-

tion, on which I have made application for letters patent. My claim in this specification, on this head, is restricted to the mechanism I have described.

"What I claim as my invention is, the arrangement of the pointing and chasing tools on the same tool-holder, in such manner that they are operated by a common motion, substantially as herein set forth."

41. For an *Improvement in Machines for Cutting Whale Blubber;* Lydoriann Ricketson, (Administratrix of Henry H. Ricketson, dec'd,) New Bedford, Massachusetts.

Claim.—"I am aware that in machines for cutting straw, or such like matters, a cutting cylinder has been made to operate on a bed roller, and that the knives on the said cutting cylinder have been arranged in a helix upon it. It is not claimed that such constitutes in any respect the invention of the said Ricketson, deceased.

"But what is claimed is, the wheel, composed of two or more spiral knives, made to rotate on an axis arranged parallel and in the direction of movement of the strip of blubber to be cut, all substantially as above set forth, meaning to claim two or more spiral knives, formed, arranged, and made to operate with respect to and in combination with a set of bed and feed rollers, substantially in the manner and for the purpose of cutting blubber, substantially as above described."

DECEMBER 21ST.

42. For an *Improvement in Rakes to Grain Harvesters;* Jearum Atkins, Chelsea, Ill.

"The nature of my invention consists in so hanging and operating the rake as that it travels across the platform at a right angle to the draft, for collecting and compressing the grain against a palm, or hand, which, together with the rake, clutches the gavel so formed, and swinging partly round, delivers it in rear of the machine."

Claim.—"Having described my invention, I desire to state that I do not confine myself to the exact mechanical devices and arrangements shown and described, for operating the rake, as these may be modified, or others substituted for them. What I claim is, the exclusive use of the herein described combination of the crane-post, rock-shaft and crank, to operate the jointed arm and hands, which collect the grain in gavels and deposit it in rear of the harvester in the manner specified, as the machine moves forward, when applied to machines for harvesting any grain which requires to be so collected and deposited, the combination being connected by gearing with the driving wheel of the harvester, and operating through mechanical devices, substantially as described, as an automaton, to perform the above specified operations."

43. For an *Improvement in Water Closets;* Wm. S. Carr, City of New York.

Claim.—"I am aware that a hopper closet has been made, in which the weight of the person caused a cock, something similar to that herein shown, to let the water into the hopper-shaped pan, and I am also aware that closets have been made, in which the pan was moved away by the motion of the seat, and the water made to run; but I am not aware of any previous arrangement, in which an air tight reservoir has been used, the filling or partial filling being effected by motion of the seat letting on the water, and when the weight is removed from the seat, the supply of the water is shut off, and a connexion opened between the air vessel or reservoir, and the pan or basin of the closet.

"Neither am I aware of any arrangement of the parts by which the pressure of water opens the pan, thereby avoiding a separate and distinct operation by hand, always subject to neglect or hasty and improper performance, by which the water has not time to act. I do not claim any of the parts of the pan, basin, or hopper, as these may be of any desired character, and if used with the hopper closet, without a pan, the parts which move the pan may be dispensed with.

"What I desire to secure by letters patent is, the cylinder and plunger, by which the force of the water is made to raise the lever, depressing and emptying the pan, as described and shown."

44. For an *Improvement in Ventilators;* A. S. Dozier, Norfolk, Virginia.

Claim.—"Having described my improved ventilator, and the method of operating the same, I wish it to be understood that I do not claim a ventilator with slats or shutters fixed in the sides of a cupola or dome, or other structure, placed on the top of the building, or elsewhere; but what I do claim as my invention is, the arrangement of the frame in the sides of the cupola or dome, projecting slightly beyond the face thereof, to admit

the lips or turned ends of the slats or shutters, to lap over the same, in order to form tight joints, and the manner of hinging or jointing the slats or shutters to the same by the joint pins.

"I likewise claim the radial wings when combined with the frame of the dome or cupola, for directing the currents of air to the spaces between the slats or shutters, as described, and thence to the trunk."

45. For an *Improvement in Straw Cutters;* Warren Gale, Louisville, Kentucky.

Claim.—"What I claim as my invention is, constructing the rotating cutting cylinder, substantially as described, with a series of parallel annular grooves and ridges, and a series of cutting arms, or knives, in combination with a series of fixed knives, so arranged that they enter the grooves and interlock or lap past the annular ridges on the cylinder, and thereby prevent the stalks of straw, &c., from descending between the fixed knives and cylinder without being cut, substantially as herein set forth."

46. For an *Improvement in Ploughs;* Wm. A. Gates, Mount Comfort, Tennessee.

Claim.—"Having described my improvement in the cotton scraper, what I claim as my invention is, the rhomboidal plate, bent on one of its diagonals, and constructed and arranged substantially as described, so that either leaf can be used as a landside, or share, at pleasure; the edges of the share becoming, when the plate is reversed, the edges of the landside, and those of the landside the edges of the share, in the manner and for the purposes specified.

"I also claim, in combination with the plate as described, the double bifurcated brace for attaching said plate to the beam, substantially as described."

47. For *Improvements in Machinery for Manufacturing Hat Bodies;* Lansing E. Hopkins, City of New York.

Claim.—"I do not claim the conical vibrating rollers for the purpose of felting or compressing a bat or the cone separately, as that is well known. But I claim combining the hardening rollers with the perforated cone, by means of a yielding or hinged frame, in which they are placed, substantially in the manner and for the purpose herein described.

"I also claim giving to said rollers, in combination with said perforated cone, a vibrating endwise motion, as well as a rotary motion, substantially as described and for the purpose set forth.

"I also claim blowing the exhaust air from the former into the chamber, for the purpose and in the manner described.

"And I also claim the mode of forming the steam pipe outlet as above specified, by covering the steam-pipe with cloth, and in casing it with an outer metal case.

"I also claim covering the perforated cone, preparatory to a deposition of fur thereon, with a covering of thin cloth, easily pervious to air, upon which the fur is to be deposited; said cloth or fabric to be removed at each operation, with the hat body deposited thereon."

48. For an *Improvement in Grain Threshers and Cleaners;* John Jones and Alexander Lyle, Rochester, New York.

Claim.—"Having described the construction and operation of our machine, what we claim as our invention is, the combination of the upright threshing and separating cylinders, with the upright concave and cylindrical sieves, operating in the manner and for the purpose as herein set forth."

49. For an *Improved Equalizing Apparatus for Engines which use Steam Expansively;* Wm. H. Morrison, Indianapolis, Indiana.

Claim.—"Having described the nature of my method of equalizing the action of steam, I claim therein as new and of my invention, the application to a reciprocating engine (in which the steam is used expansively) of the described or equivalent toggle movement, in combination with a pair of equalizing cylinders, which, being placed at a greater or less distance, (one on each side of the mid range of the toggle,) the most rapid accumulation of equalizing force is made to take place earlier or later in the stroke, in accordance with the period of cut-off, &c., for the purposes herein described."

50. For an *Improvement in Maize Harvesters;* Jacob L. Ream, Mount Pulaski, Ill.

Claim.—"Having described my improvement, what I claim as my invention is, the arrangement of the shaft of the receiving arms with one end resting upon the cutter bar-piece, thereby dispensing with an intermediate platform, so that the cut stalks will fall

directly upon the receiving arms, and be thence discharged in bundles upon the ground, as set forth."

51. *For Cut-off Valve Motion;* S. W. Rogers, Baltimore, Maryland.

"The nature of my invention consists in a particular arrangement for operating the cut-off valve."

Claim.—"Having fully described my invention, I do not claim placing the cut-off valve outside of the slide valve, and operating both valves by one rod or eccentric. But I do claim the lugs acting upon the hinged levers, attached at their lower extremities to the cut-off slide, and at their upper to a rod capable of a vibratory movement, in a direction perpendicular to the valve seat, substantially for the purpose and in the manner set forth."

52. For an *Improvement in Potato Diggers;* Jesse N. Seeley, Forsyth, Georgia.

Claim.—"Having fully described my invention, what I claim is, the construction of a potato digger by the combined arrangement of the knife, wheel, and fork, with the beam, operating substantially as in the manner set forth."

53. For an *Improvement in Lamps for Locomotive Engines;* Thomas and Stephen Hill, Rochester, New York.

Claim.—"What we claim as our invention is, 1st, the construction of a feeder for supplying oil to the holder, by the combination of two tubes, one communicating with the interior of the reservoir, and the other fastened to a float immersed in the oil of the holder, by which the lamp is rendered self-feeding, in the manner and for the purposes herein specified.

"2d, The construction of the chimney with a broad flat flue connecting its vertical portions, the exterior one of which is so constructed as to be forward, or on either side of the prolongation of the chimney of the burner, substantially in the manner and for the purposes herein specified."

54. For an *Improvement in the Manufacture of Chromate of Soda;* John Swindells, Manchester, England; patented in England, November 14, 1850.

"My invention consists in the process for the production and manufacture of the chromate of soda, for the purposes of bleaching, printing, dyeing, and color-making."

Claim.—"Having now described the nature of my said invention, and the manner in which the same is to be performed, I hereby declare that I claim as my invention, the process described for manufacturing the chromate of soda-dyeing."

55. For an *Improvement in Fulling Mills;* Wm. E. Underwood, Middlefield, Mass.

"The nature of my invention consists in providing an attachment to the rotary fulling mill, which will, in case of the entanglement or knotting of the endless chain of cloth, causing one of the compressing rollers to slip on the cloth, that the driving belt will be thrown off, thereby stopping the machine and preventing the cloth from being damaged by the compressing rollers."

Claim.—"What I claim is, the combination of the stop mechanism, or its equivalent, with the screw pulley and the elastic band leading to the pulley on the upper roller, whereby the whole machine is stopped when the motion of the cloth is arrested in the manner described, and ceases to impart motion to the upper roller."

56. For *Machinery for separating Iron from Furnace Cinders;* Danl. Walroth, Chittenango, and Lucius Evans, Manlius, New York.

Claim.—"What we claim is, the combination of the revolving, breaking, and sifting cylinder with the fan, or its equivalent, substantially in the manner and for the purposes specified."

57. For an *Improvement in Steam Flat Irons;* Caleb C. Walworth, Boston, Mass.

Claim.—"Having explained my invention, I would have it understood that I claim the steam ball and socket smoothing iron, as made of a combination of a spherical socketed smoothing block, and a hollow or chambered sphere, with induction and eduction passages arranged so as to admit steam and discharge condensed water, all substantially as hereinbefore set forth, the block being applied to the sphere in such manner that it may be moved thereon in various directions transversely, while passing over and against a hat or surface to be smoothed, as specified."

58. For an *Improvement in Planing Machines;* Aretus A. Wilder, Detroit, Michigan; ante-dated July 17, 1852.

"The nature of my improvements consist in constructing planing machines so that the board to be planed can be clamped to the reciprocating bed, whilst being fed by the backward motion of the planes, so that the board will be free to move over the stationary bed plate upon which it is planed."

Claim.—"Having described my invention and improvement in machines for planing, tonguing, and grooving boards, I disclaim the invention of planing by a reciprocating plane, which planes on its forward stroke and feeds the board on its backward stroke, as in other machines of this class. But what I do claim in planing machines of this character is, clamping the boards when being fed by the backward motion of the planes to the reciprocating bed only, so that it will be free to move over the stationary bed plate, upon which it is planed, substantially in the manner and for the purpose described."

59. For an *Improvement in the Method of Measuring Cloth on the Cloth Beam;* Wm. H. Woodworth, Salmon Falls, New Hampshire.

Claim.—"What I claim as my invention is, connecting or attaching a measuring cord (constructed as described) to the cloth, so as to be wound on the cloth beam with it, in order to indicate the length of the 'cut' desired."

60. For an *Improved Safety Lock;* Linus Yale, Jr., Newport, New York.

Claim.—"First, I claim, in combination with the tumblers, or their equivalents, constructed and connected, respectively, to stop, in the manner, or in an equivalent manner, to that described in the specification and shown in the drawings, the spring, the same being an additional device, co-operating with the said tumblers and springs connected therewith, in rendering the movements and positions of the stops to the highest degree uncertain, when an attempt is made to unlock the lock, without using the proper key.

"Secondly, I claim the wheel and the lever, in combination with the tumblers, constructed as before described, or their equivalents, to raise, while in one position, and support the tumblers, that the key-hole shall be equal and smooth, to receive the key, and then allow them to be stopped at proper heights on the key, while a revolution is performed, and the bolt moved by the wheel, substantially as described."

DECEMBER 28TH.

61. For *Improved Parrel for Yards of Vessels;* Danl. S. Bayles, Brooklyn, N. Y.

"The nature of my invention consists in combining and arranging a rocker in front and rear of the mast, capable of motion in two planes, with rockers at the sides, to which the pearl-rope leading to the aft rocker is connected, by which the motion of the yard will be rendered free and easy, and not liable to injure the mast in cock-billing the yard, and jam in the jaws of the yoke whilst being lowered, as in the old mode of construction."

Claim.—"I do not claim the rocker simply and by itself as my invention, a saddle or slide having been heretofore used and fastened into the swallow-tail of the gaft and boom of sailing vessels, applicable to fore and aft sails only. But what I do claim as my invention is, the combination of the rocker in front of the mast, and capable of a motion in two planes with the rockers at the side of the same; said rockers being arranged with respect to each other and the yoke, substantially as described."

62. For *Improvements in the Method of obtaining Gold, &c., by Amalgamation;* M. A. Bertolet, L. Kirk, and A. M. De Hart, Reading, Pennsylvania.

Claim.—"Having described our improved method of separating precious metals from their ores by amalgamation, what we claim as new therein is, bringing of the ore, in a heated state, into contact with mercury during the process, substantially as herein set forth.

"We also claim the method of heating pulverized ore by causing it to pass in a shower through a current of some heated fluid, preparatory to bringing it into contact with the mercury, substantially as herein set forth.

"We also claim the method of heating the apparatus, the mercury, and the ore, by means of a current of heated fluid, circulated through chambers and pipes, substantially as described, whereby a single current of a suitably heated fluid, and a single system of circulating pipes of simple construction and compact arrangement, are made to heat the whole

of the apparatus that requires to be heated, and to heat the ore in the process of feeding and the mercury in the process of amalgamating, substantially as specified."

63. For an *Improvement in Winnowing Machines;* Samuel Canby, Ellicott's Mills, Maryland.

Claim.—"Having fully described my improvements in grain winnowers, what I claim as my invention is, the combination of the piston, rack rod, pinion, valves, and eccentric pulley, in connexion with a conducting chest and blower, for the automatic graduation or government of the blast through the spouts of a winnowing machine, arranged and operating in the manner and for the purpose set forth."

64. For an *Improvement in the Process of Making Illuminating Gas;* George Danre, Pascal Nicolas, and Felix Lopez, Marseilles, France.

Claim.—"What we claim as our invention is, the combination of woody and fatty substances in gas generators, as described, so that the excess of hydrogen in the former may combine with the excess of carbon in the latter, and produce a rich carburetted gas of any required density, and free from sulphurous fumes."

65. For an *Improvement in Temples for Looms;* Elihu and Warren W. Dutcher, North Bennington, Vermont.

"Our invention consists in arranging a reciprocating "roller temple," so as to accommodate itself to the back and forth or yielding motion of the cloth, as produced by the beat of the lay, whereby the temples may be set up closer than usual to the reeds, without danger of the latter being damaged by striking the former."

Claim.—"Having described our improved weavers' temple, what we claim as new therein is, 1st, The arrangement of parts, so that the temples have a reciprocating action corresponding with the motion given to the cloth by the beat of the lay, substantially as herein set forth."

66. For an *Improvement in Cutting Paper;* John P. Farnum, Assignor to himself, Jacob Jenkins and Charles B. Clark, Andover, Massachusetts.

Claim.—"Having described the elements of the combination invented by me, and explained the mechanism I have adopted for putting them in action in the manner as hereinbefore specified, I do not intend to confine my invention to the precise form or arrangement of its parts as represented in the drawings; but intend to vary the same to any extent, while I do not change the character of the machine.

"What I claim is, the combination of a press, or its equivalent, for holding the book or paper to be cut, with one or more cutters or knives, for trimming the front or one edge, and one or more cutters for trimming one or both of the other edges of the book, the different sets of cutters being simultaneously operated, while the paper or press is moved towards them, all substantially as above specified.

"And in combination with such cutters or knives for trimming one, or the front and other edges of a book, at one operation or time, I claim the improvement of combining with them, or either of them, one or more polishing surfaces as described, or their equivalents, whereby the edges of the sheets of paper are cut and polished or smoothed, ready for gilding, substantially as specified."

67. For an *Improved Mode of Mounting the Cutters of Machines for Planing Metals, &c.;* Pierre Saulnier, Assignor to John T. Bruen, City of New York.

Claim.—"I wish it to be understood that I do not limit myself to the special mode of construction herein specified, as this may be changed at pleasure, so long as the principle or character of my invention is retained.

"What I claim as my invention is, hanging the cutters to the stock by means of a joint pin, or its equivalent, whose axis is diagonal to the line of cutting motion, and in a plane parallel with the surface, being cut, substantially as specified, for the purpose of relieving the cutting edge in two directions as specified, when the cutter-stock is set perpendicular to the plane of the surface to be produced.

"And I also claim combining together in one cutter-stock two cutters, hung substantially as specified, and with the angle of the axis of the two joint-pins reversed as specified, for the purpose of relieving both cutters from the two surfaces, when cutting in both directions, as specified."

68. For an *Improvement in Magnetic Printing Telegraph;* Royal E. House, City of New York.

"The nature of my invention and improvement consists in certain machinery for com-

posing and printing, at the same time at one operation, which machinery, when combined with electrical or galvanic apparatus, is capable of effecting the operation of immediately any characters which may be selected by the compositor, even though the printing press be removed to a distance from the composing machine; and therefore, I design, by the use of certain electrical apparatus, as improved by me, to apply, among other things, the said machinery to the publishing messages in ordinary typography, and also signalizing messages at great distances, as means of communicating intelligence.

Claim.—"What I claim as my own invention is, 1st, The employment of electro-magnetic force, in combination with the force of a current of air or other fluid, so that the action of the former governs or controls the action of the latter for the purpose described.

"2d, I claim the construction of the electro-magnet as described, that is to say, a series of fixed magnets in combination with a series of movable magnets, arranged upon a central axis, which axis plays between or through the line of fixed magnets, so as to effect a vibratory movement of said axis by a force multiplied by the number of magnets of both kinds.

"3d, I claim the combination of the electro-magnet with the valve, for regulating and directing the force of a current of air or other fluid, acting as a motive power upon the piston, or other analogous device, for producing a vibratory motion, as described.

"4th, I claim the endless band, in combination with the cylinder, as an inking machine, for conveying and applying the coloring matter to the paper at the moment of receiving the impression from the types, as described.

"5th, I claim the combination of the regulating bar with the type wheel for the purpose of regulating the proper position said wheel should have in connexion with a given position of the key shaft, at the moment of printing any letters or characters."

69. *For Machinery for Heading Bolts, &c.;* Edward Paye, Albany, New York.

Claim.—"What I claim as my invention is, 1st, The combination of the stationary die and die pivot with the sliding hammers, actuated by the rotary grooved cams or cam collar, substantially as described, for the purpose set forth.

"2d, The revolving ring or cam collar, provided with cams or their equivalents, on its inner and outer surfaces, when arranged with radial compressing and sliding upsetting hammers, in the manner and for the purposes described."

70. For an *Improvement in Shuttles for Looms;* Wm. Tucker, Blackstone, Mass.

"The object of my improvement is to prevent the weaving of 'bad places' in cloth, or the consequences that generally result from the breakage of one of the warp threads; when this occurs, the movements of the lay so entangle the loose, broken warp threads in the adjacent warp, as to cause the latter to make an improper decussation, whereby, what weavers term a 'bad place' will be woven or made in the cloth, until the broken warp-thread is repaired.

Claim.—"What I claim as my invention is, the combination of the elevator, the bent spring, the platform, and its recess, the passage and the slot, as applied to the shuttle and cop spindle, and made to operate together, substantially in manner and for the purpose of causing the filling thread to be broken, so that no filling thread shall be woven into the warps, under circumstances as hereinbefore stated."

71. For an *Improved Method of Heading Screw Blanks, Rivets, &c.;* Wm. E. Ward, Portchester, New York.

Claim.—"What I claim as my invention is, in combination with the swedge-header and die-plate, substantially as specified, the giving of a back or receding movement at the end of the heading operation to the follower, against which the point of the rod rests during the heading operation, substantially as specified, that the rod or wire may be upset, outside of the die, whilst resistance is made by the follower against the end of the rod, and then as the follower retires, cause the part so upset to be griped between the surface of the die and the swedge, to complete the form of the head, the surplus metal being thereby forced into the blank, as set forth."

72. For an *Improved Safety Apparatus for Steam Boilers;* Henry Waterman, Williamsburg, New York.

Claim.—"What I claim as my invention is, 1st, The safety chamber and safety plate, combined with the boiler in any way substantially as described, whereby the bursting of the plate by the too high pressure in the boiler, causes the chamber to be filled, and the pressure in the boiler to be reduced by the expansion of the steam.

2d, The plate placed, substantially as described, between the boiler and the safety

plate, having one or more small openings, through which the steam is allowed to pass, to act on the safety plate and fill the safety chamber, whereby the water is prevented from priming or foaming, and being carried up by the steam when the safety plate bursts."

73. For *Machinery for making Railroad Chairs;* John F. Winslow and John Snyder, Troy, New York.

Claim.—"We have described the mode of construction and arrangement, which we have essayed with success; but we do not wish to be understood as confining ourselves thereto, as the construction and arrangement may be greatly varied, without changing the principle of our invention.

"What we claim as our invention is, the movable cutter for making the cuts in the edges of the plate, substantially as described, in combination with the slides, which answer the purpose of stationary cutters and rests, to effect the partial bending of the lips, and which afterwards complete the bending of the lips, substantially as described.

"We also claim, in combination with the cutter, as described, the making of the mould or former to slide therein, for discharging the chair after it has been formed as described.

"And finally, we claim the dies for upsetting and giving additional thickness to the lips, as described, in combination with the bending slides and cutters, substantially as described."

74. For an *Improvement in Daguerreotyping;* Wm. Yarnall, Newark, Ohio.

"The nature of my invention and improvements consists in chemically producing ornamental borders or marginal designs of a variety of hues and tints, colors and shades, or encircling the photographic image with a succession of circles, halves and irradiations."

Claim.—"What I claim as my invention is, the producing ornamental borders and designs of different shades and forms, and singly or in numbers, around any photographic image, by the method of irregular chemicalization, combined with the use of pattern slides, or chemical cut-offs, all of which is fully described in the detail of my process."

Designs for December, 1852.

1. For a *Design for a Cook Stove;* Ezra Ripley and N. S. Vedder, Troy, Assignors to Samuel McClure, Rochester, New York, December 7.

Claim.—"Having described our design of cook stove, what we claim as new is, the ornamental design and configuration of cook stove, such as herein described."

2. For a *Design for a Box Stove;* James Wager, Volney Richmond, and Harvey Smith, Troy, New York, December 14.

Claim.—"Having fully described our design, what we claim therein as new is, the foregoing configuration of the ornaments upon the plates, forming an ornamental design for a stove, illustrated and represented by the drawings."

3. For a *Design for Iron Railing;* Nicholas T. Horton, Cincinnati, Ohio, December 14.

Claim.—"What I claim as my invention is, a design for ornamental iron railings, as described in the above specification."

4. For a *Design for a Coal Stove;* Gilbert Knapp and Adnah H. Neal, Honesdale, Pennsylvania, December 14.

Claim.—"What I claim as my invention is, the ornamental design and configuration of the stove and door, and also the ornamental openings, in combination with the different mouldings, as herein shown and described."

5. For a *Design for Stove Plates;* Sherman S. Jewett and Francis H. Root, Buffalo, New York, December 21.

Claim.—"Having described our ornamental design for stove plates, what we claim as new therein is, the embellished panel of the plate, of the configuration herein represented and described."

6. For a *Design for a Cooking Stove;* Sherman S. Jewett and Francis H. Root, Buffalo, New York, December 21.

Claim.—"Having described our ornamental design for cooking stoves, what we claim as new therein is, the configuration and arrangement of the several devices ornamenting the panels and doors, the same consisting of annular mouldings surrounding the apex of a dished or hollow cone surface, formed of converging fillets, whose outer ends form a scolloped outline or border for the panel, as represented and described."

7. For a *Design for a Hearth Plate;* James Wager, Volney Richmond, and Harvey Smith, Troy, New York, December 21.

Claim.—"Having fully described our design, what we claim as new is, the foregoing design for a stove, as illustrated and represented by the drawings."

8. For a *Design for a Spittoon;* Washington L. and Sylvester W. Pearsall, City of New York, December 21.

Claim.—"We claim the design of the shape and configuration of spittoon shown in the drawing."

9. For a *Design for a Girandole;* Robert E. Dietz, City of New York, December 28.

Claim.—"What I claim as my production is, the arrangement and combination of the foliage, drapery, human figures, and flowers, as set forth in the accompanying drawings, forming an ornamental design for a girandole."

JANUARY 4TH.

1. For an *Improvement in Machines for Heckling Flax and Hemp;* James P. Arnold, Louisville, Kentucky.

Claim.—"I do not confine myself to any particular form or arrangement of the parts, so long as the machine is so constructed that it will operate substantially in the manner herein set forth; the form I have described and represented is the one that I have essayed with success, and therefore deem it sufficient to show how my invention may be practically carried into effect.

"What I claim as my invention is, the method of heckling hemp by subjecting it to the action of a series of mixed beaters and combs, the teeth of the latter being of varying length, some of them projecting so far, and others beyond the beaters, and the whole operating substantially in the manner herein set forth.

"I also claim a rest, having a narrow slot open at one end, in combination with a concave, projecting beyond the end of the cylinder at the open end of the rest, substantially in the manner herein set forth."

2. For an *Improvement in Machines for Sawing Stone;* John T. Bruen and James G. Wilson, Hastings, New York.

Claim.—"What we claim as our invention in the sawing of marble and other stone is, lifting the saws at or sufficiently near the middle of the stroke, to effect the herein specified purpose, substantially in the manner specified.

"We also claim interposing india rubber, or its equivalent, between the ways and the inclined projections which lift the saw-frame, substantially in the manner and for the purpose specified."

3. For an *Improvement in Self-Winding Telegraphic Registers;* James J. Clark, Philadelphia, Pennsylvania.

Claim.—"I do not desire to claim the application of the click and ratchet wheel, operated by an electro-magnet, vibrating a lever, to cause rotation and obtain power; but what I do claim is, regulating the current through the coil of the electro-magnet of the self-winding apparatus by means of the relative motion of the spring shaft and spring box, so that when the spring has been wound up to a certain point that current shall be cut off, and the self-winding apparatus cease to act."

4. For an *Improvement in Machines for Planing Mouldings;* John D. Dale, Philadelphia, Pennsylvania.

"The nature of my invention consists in arranging a series of moulding cutters or plane irons, side by side, and along the length of and around an axis of rotation, when this is combined with rotating saws or their equivalents, for slitting or separating the several mouldings at the same operation, whereby the operations are not only simplified, but accurate work is insured."

Claim.—"What I claim as my invention is, arranging a series of sets of moulding cutters or plane irons, side by side, along the length of a rotating stock, substantially as specified, when this is combined with rotating saws, or their equivalents, interposed and projecting beyond the periphery of the cutter for separating the several mouldings formed on one plank, substantially as specified, whereby the operations of planing the several

mouldings, and separating them, are performed at one and the same operation, and accuracy of work secured, as set forth."

5. For an *Improvement in Machines for Planing Mouldings;* John D. Dale, Philadelphia, Pennsylvania.

Claim.—"I do not wish to limit myself to the number of knives or rollers to be used, nor to the manner of operating the rollers, as these may be varied at pleasure. And I wish it to be understood, that I do not wish to limit myself to the use of all my improvements in one machine, although the best results will be produced by the employment of all of them.

"What I claim as my invention is, attaching the planing iron to a plane stock, which is hinged to an adjustable sliding plate, substantially as specified, by means of which combination the plane iron can be readily thrown up, to be sharpened, without the necessity of taking it out of the machine, as set forth.

"I also claim the adjustable sliding plane, substantially such as described, when combined with the separate movable mouth piece, by the means substantially such as herein described, so that in setting the plane iron, a differential motion is given to the mouth piece, in order to vary to any desired thickness the shaving, that when the plane is set to cut a thick or thin shaving, the mouth piece shall receive a corresponding set, as described."

6. For an *Improvement in Grain Washers;* George Feaga and George W. Feaga, Frederick, Maryland.

"The nature of our invention consists, First, In washing the grain in water, by which means the smut is loosened, and in which the smut, garlic, and all other light impurities will rise and pass off with the water, and then carrying the washed grain by elevators or otherwise, and passing it over or through a chamber or chambers, heated by steam or hot air, where it is thoroughly dried, and thence to the stones for grinding."

Claim.—"Having thus fully set forth the nature of our invention, and shown the means of putting it into practical use, what we claim therein as new is, the method herein described of separating grain from smut, garlic, and other impurities, by first washing it in a trough or reservoir of water, where the separation takes place, and then conveying the washed grain to a drying apparatus, where it is thoroughly dried—the whole operation being performed substantially in the manner herein set forth and described."

7. For an *Improvement in Crutches;* John S. Gallaher, Jr., Washington, D. C.

Claim.—"Having described the construction and operation of my improved crutch, what I claim is, First, The revolving plain or corrugated spring top, in combination with an air cushion, substantially as above described.

"Second, I claim, in combination with the revolving spring top, the sliding joint applied to the staff of a crutch, in the manner and for the purpose described.

"Third, I claim, in combination with the sliding staff, the revolving handle, extension ferrule, and elastic bulb, as above described and set forth in the accompanying drawing."

8. For an *Improvement in Hill-side Ploughs;* John C. Bidwell and John Hall, Executors of Samuel Hall, deceased, Pittsburg, Pennsylvania.

Claim.—"What we claim as the invention of Samuel Hall is, the manner of arranging the mould boards upon the land-side, to wit: placing their hinges at such a distance from each other, on each side of the centre of the land-side, that each mould board may be supported by the edges and projection as far as practicable, from the hinges, and rest upon the grooves near the middle of the land-side, substantially for the purposes herein set forth."

9. For an *Improvement in Hose Pipes;* Richard Hollings, Boston, Massachusetts.

Claim.—"What I claim as my invention is, hanging the spread to the hose-pipe by means of pins passing through the collar, (which allow it to vibrate,) in combination with adjusting apparatus for varying the position of the spread, in the manner specified."

10. For an *Improvement in Lathes for Turning Irregular Forms;* Benj. F. Jenkins and Luke L. Knight, Barre, Massachusetts.

"This invention relates to that description of lathe, in which the work and cutters both revolve, and the irregularity of form is produced by the vibration of the axes of the work, and of the whole or part of the cutters—the improvements consist in certain simple and effective means of controlling the vibrations of the said axes."

Claim.—"We do not claim the vibrating cutter cylinder and vibrating work carriage, but what we claim is, giving the necessary relative vibrations to the cutter cylinder and work carriage by crank pins or eccentrics, upon the axes of a pair of toothed wheels, of which one is toothed all round its periphery, and the other upon any suitable portion of its periphery—the latter wheel having a constant rotary motion applied, which gives an intermittent rotary motion to the former wheel, whereby the said cutter cylinder and work carriage receive, the one a constant vibratory motion, and the other an intermittent vibratory motion, substantially as described."

11. For *Improvements in Ore Washers;* Merritt Peckham and Lucius O. Palmer, Utica, New York.

Claim.—"We claim as our invention, the interior cylinder with indented ends and wings, attached as described, to operate as a discharging apparatus, attached to the interior of an inclined revolving screen, in the manner and for the purpose specified."

12. For an *Improvement in Potato Diggers;* Francis C. Schaffer, Brooklyn, New York.

"The nature of my invention consists in the arrangement and construction of an endless apron and scoop, which will be hereafter described, and by which arrangement and combination potatoes are dug and scooped from the hills, and conveyed by the aid of a brush cylinder into a proper receptacle or box, the potatoes being thoroughly cleansed from dirt, in consequence of passing up the inclined apron."

Claim.—"I am aware that machines have been previously used for digging potatoes, but in these machines the potatoes are dug or scooped from the hills by means of a concave or scoop, formed of a single piece, the brush cylinder carrying the potatoes up the concave and into the receptacle. I therefore do not claim the above arrangement, but what I do claim as new is, the arrangement and combination of the scoop and endless apron, by which the potatoes dug or scooped from the hills, and the dirt thoroughly separated therefrom as they pass up the endless apron into the receptacle."

13. For an *Improvement in Tonguing and Grooving Machines;* William Watson, Chicago, Illinois.

Claim.—"Having thus described my improvements in tonguing and grooving machines, what I claim therein as new is, the method substantially as herein described, of tonguing and grooving boards by means of knives arranged in the plane of the sides of the tongues or grooves, with their cutting edges inclined towards their rear extremities, so as to cut gradually deeper and deeper as the board passes them, when in combination with cutting instruments arranged between these side knives, to reduce or remove the surplus wood which is severed by them, substantially as herein specified."

14. For an *Improvement in Printing Presses;* Jeptha A. Wilkinson, Fireplace, New York.

Claim.—"I am not aware that type have ever been formed with two parallel sides and two sides tapering on the radii of a circle, with a groove on one side and a projection on the other, so that on setting the parallel sides together and the tapering sides together, and placing the projecting beads into the corresponding grooves, a cylinder is formed of firmly secured type, with their faces equi-distant from the centre, by which means the printing is effected, the same as though the whole was solid in a perfect cylindrical form; this constitutes the essence of my invention, and the other parts claimed are the means to use, to form, regulate and work this main invention, and for parts growing out of or connected with the same.

"1st, The application of notches or grooves and beads or projections on the shafts of type, tapered to the radii of a circle, for the purpose of locking said type together, and securing it in place on a cylinder, substantially as described and shown.

"2d, The mode described and shown, of forming column lines, rules, rings, and blocking, so that they are adapted to the cylinder and to the type, with notches and projections, to lock into the type and cylinder, substantially as described and shown.

"3d, The mode described and shown, of constructing the type cylinder with heads, the one head having a bead or projection, the other with a notch or groove around in its face near the edge, for the purpose of receiving and securing the type or other parts composed on the surface of said cylinders, such heads being fitted with means to compress and hold the type and parts in a cylindrical form, for the purpose of printing, by a rotary movement, substantially as described and shown.

"4th, The mode of constructing the compositor's sticks in the form of a part of a cylin-

der with flanches having beads or grooves, so as to hold the type in segments of a circle while composing or setting up, preparatory to the placing of the same in the galley or proof cylinder, substantially as described and shown.

"5th, The mode of constructing and applying the galley or proof cylinder, so that it shall receive and hold the type, in circular form, from the composing stick, and retain the type and the needful parts in place, for correction and proof, and for transferring the same to the type cylinder, the parts being constructed and operating substantially as described and shown.

"6th, The mode of forming and constructing the type-holder or grab, to enclose, take hold of, and securely lift a mass of type from the galley, or proof cylinder, and transfer the mass either to the type cylinder, or to a stack for future use, or to reverse or vary either of these operations as may be needed, the instrument being constructed and operated in the manner and with the effects described and shown.

"7th, The application and arrangement of the pulleys, bands, and guide plates, so placed and moving, so as to carry the sheet of paper from the press in lines diverging vertically, and converging horizontally, under, between, and over the guide plates, thereby presenting the paper in a folded form to the compressing rollers, substantially in the manner and with the effects described and shown.

"8th, The application of the press rollers, to compress the folded paper and lead that out of the folding apparatus, and the combination of the standing roller, revolving shear, standing shear, valve, and cam, to effect the cutting of the folded paper as it issues from the rollers, and guide the fresh cut edge clear of the standing shear, the whole of the parts being constructed, arranged, combined, and operating substantially as described and shown."

15. For an *Improvement in Covering Piano Forte Hammers;* Rudolph Kreter, Assignor to Robert Nunns and John Clark, City of New York.

Claim.—"What I claim as my own invention is, First, The application of the felt or other covering material to the whole set of hammer heads at one operation, in the manner described.

"Second, I claim the clamp, bar, levers, pulleys, and block, with the sliding frame, in combination, substantially as described, but without limiting myself to the precise shapes and proportions or positions of the said parts, provided the arrangement embrace the means of holding the set of hammer heads, and of bringing them to bear upon a table containing the strips of felt described, and also holding and moving the whole together either horizontally or vertically to and from the jaws of the vise, as set forth.

"Third, I claim the vise in combination with and in closing the bar and block, as described.

"Fourth, I claim the lip pieces in combination with said vise, for the purpose described.

"Fifth, I claim the levers and springs in combination with the vise, for producing the pressure upon the sides of the felt during the passage of the hammer heads between the jaws of the vise, as described.

"Sixth, I claim the method of increasing or diminishing the pressure of the levers upon the vise by means of the movable bridge in combination with the press, as described."

16. For an *Improvement in Bottle Stoppers;* Walter Hunt, Assignor to Chas. T. Kipp, City of New York.

Claim.—"I am aware that there have been other plans of self-acting stoppers, recently introduced; I allude to the bi-valves, hinged at the top, which, in short, is nothing more than the valve of the treacle cup duplicated, and its application to rura instead of molasses; there are also other plans of recent date, which have sprung up since mine were commenced, constructed upon the principle of puppet valves, all of which have the same objection, of producing an uncertain scattering or over discharge, and are constructed upon principles widely different from my above described plan, and to which I make no claim in this application. But what I do claim is, the combination of the circular cap and the central shaft, viz: the swivel, pendulous and sliding motions, by means of which without regard to which side of the stopper is upward, (when it is placed horizontally, or nearly so,) the under portion of the cap swings off from the flanch, thereby producing a downward opening between the two, for the requisite discharge of the liquids contained."

MECHANICS, PHYSICS, AND CHEMISTRY.

On Improved Fire Brick Gas Retorts. By Mr. John E. Clift.*

The object of this paper is to describe a plan for constructing gas retorts, which the writer has had in use several years at the works under his management, and has also adopted at various other towns.

The first great desideratum in a gas generating retort is on all hands acknowledged to be a large surface, upon which may be spread a thin layer of coal: this was early shown by Mr. Clegg, in his invention of the revolving web retort,—the only difficulty in working which was the destructible nature of the material of which it was composed.

The second condition required is, that this large surface shall be economically heated. A strong opinion existed, for a long time, against the use of fire clay for retorts, in consequence of the inferior heat-conducting properties of that material compared with iron; but experience has proved that as large a quantity of gas can be generated, with a given weight of fuel, with fire clay retorts as with iron. This may be accounted for partly by the fire clay losing less of its heat on being exposed to the air whilst charging, and on the cold charge of coal being first thrown in; or, in other words, that the greater mass of fire clay acts as a reservoir of heat, and does not become so readily exhausted when a large demand is made upon it, but, on the contrary, maintains a greater uniformity of temperature throughout the process: this is easily demonstrated by observing the small quantity of gas made from an iron retort, during the first hour after charging, compared with a fire clay one. It is also partly accounted for by the iron retorts, as they are generally set, being so covered and shielded with fire bricks, to preserve them from destruction, as to partake as much of the character of clay retorts as of iron.

The following table, which is the average of a number of experiments, gives the quantities of gas generated, as indicated by the meter, from iron and clay retorts, during each half hour of the charge, from the same quantity and quality of coal:—

IRON RETORTS.		BRICK RETORTS.	
1 half hour,	250 cubic feet.	1 half hour,	480 cubic feet.
2 "	630 "	2 "	1800 "
3 "	1340 "	3 "	2000 "
4 "	2300 "	4 "	2000 "
5 "	2600 "	5 "	2300 "
6 "	2610 "	6 "	2300 "
7 "	2600 "	7 "	2460 "
8 "	2600 "	8 "	2400 "
9 "	1700 "	9 "	2000 "
10 "	1630 "	10 "	1630 "
11 "	1790 "	11 "	860 "
12 "	700 "	12 "	550 "
Total,	20780	Total,	20780

The third requisite in a retort is durability. The proper way to measure this element is to divide the quantity of gas made, by the cost of the re-

* From the London Journal of Arts and Sciences, October, 1852.

torts and ovens, and the repairs during the time they are worked: this will be shown presently by a comparison from the actual working of iron and clay retorts.

The retorts to be described in the present paper are composed entirely of fire bricks, with cast iron front plates to attach the mouth pieces to, and to bind the brickwork together; and they are made of any length, width, or height. They are generally constructed in sets of three, with one large retort above and two smaller ones beneath, as shown in the drawings which accompanied the paper. The cast iron front plates are $1\frac{1}{8}$ inch thick. The wrought iron stays for the same are $4 \times 1\frac{1}{2}$ inches, and are fastened at the bottom by cramps built into the brickwork, and at the top by tension bars, connected to similar stays on the opposite side.

The two lower retorts are 15 inches wide, 15 inches high, and 20 feet long, with a mouth piece at each end. The fire bricks, forming the bottoms and sides of the retorts, are 16 inches long and 3 inches thick; and the arch bricks, forming the top, are 9 inches long by $3\frac{1}{2}$ inches deep. Each brick is rebated 1 inch deep in the transverse joints, and grooved in the longitudinal joints; and these grooves are filled with stiff fire clay when they are put together, which burns into a hard tongue, half an inch thick, as it becomes heated: the object of these tongues is two-fold,—they offer a resistance to the leakage of the gas by breaking the joint, and they tie together the arch of the retort.

The large upper retort is 5 feet 3 inches wide, and 20 feet long, and open for charging at both ends. The bricks are similar to those forming the small lower retorts. There is a cross arch, 5 inches thick, spanning the furnace flat on the top, which covers the under side of the transverse joints of the bottom of the large retort; and the longitudinal joints are covered by small arched bricks. Two furnaces are employed, one at each end of the oven, separated by a transverse wall. In rising from each furnace, the heat passes partly underneath and partly over the small retorts into the first flue, at either side of the large retort; and thence it proceeds through a series of flues above that retort into a main flue leading to the chimney. By this arrangement, the heat is caused to pass over 50 feet length of surface of retort from the time it leaves the furnace until it reaches the main flue.

With regard to durability, the writer states that 12 sets of these retorts were put up by him in 1842, and worked constantly, with the exception of short periods, up to 1849, when they were taken down for the alteration of the works, and they were found then in good condition, and were fit for working several years longer with slight repairs. The writer also put up 12 sets of these retorts in 1844, and they continue in regular work now, and are in good condition: the cost of repairs of the retorts, ovens, and furnaces, during the eight years they have worked, has not exceeded 20*s*. per annum for each set.

The writer accounts for the durability and economy of retorts constructed on this plan, firstly, by their being composed of a great number of pieces, instead of only one; so that when their temperature is altered, either by the carelessness of the stokers, or in letting down the heat to throw the retort out of work, each joint opens a little, equal to the contraction of a 9 inch brick, and prevents any portion of the retort cracking. In the same way, in getting up the heat (which is a time when a great

number of clay retorts made in one piece are destroyed), if one portion of the retort becomes heated more than another, the joints accommodate the expansion; or, if the brickwork is in a very green state, and the expansion from the moisture is great, the screws of the tension rods may be eased, which will allow the whole mass of brickwork to swell; but, as soon as the moisture is expelled, it will sink back into its place, and be as perfect as when first built. When a set of these retorts is first put to work, either new, or after being let down for any purpose, it leaks through the joints for about 24 hours, gradually stopping; and, after that time, if the heat be good, it will have become quite sound, and permanently gas tight, under a pressure equal to 10 or 12 inches head of water.

From a sufficiently long experience, the writer has proved that brick retorts, built upon this plan, will wear for 10 years, with the outlay of 20*s.* per annum for repairs, and that iron retorts will not last more than 1½ years, under the most favorable circumstances. Then to show their comparative economy, take a number, say 20 sets or beds of iron retorts and 20 beds of brick retorts,—each bed being capable of making 20,000 cubic feet of gas in 24 hours; and to make the calculations as correct as possible, let the cost and repairs of each be estimated, and the quantity of gas they will make, during a period of 10 years, in order to ascertain the cost of the gas produced from each plan per 10,000 cubic feet.

First cost of 20 beds of iron retorts:—				
Bricks, clay, and labor, for arches,			£367	0 0
100 cast iron retorts, 18 cwt. each, 90 tons, at £6,			540	0 0
Fire bricks, shields, quarries, &c., for setting,			150	0 0
Labor for setting, 60*s.* each set,			60	0 0
Cost of renewing 20 beds of iron retorts:—				
100 iron retorts, 90 tons, at £6,	£540 0 0			
Bricks and clay,	150 0 0			
Labor, taking down, and resetting,	80 0 0			
	£770 0 0			
Less by old burnt iron, 50 tons, at 25*s.*,	£62 10 0			
Less by one-third of bricks, which may be used again,	50 0 0			
	112 10 0			
	£657 10 0			
This sum will be multiplied by 6½ the number of times they will be renewed in 10 years, which will give			4270	10 0
Making the total expense of iron retorts,			£5387	10 0
First cost of 20 beds of brick retorts:—				
Bricks, clay, and labor, for arches,			£367	0 0
Iron for front plates and brick stays, 21 tons, at £6,			126	0 0
Pattern and other bricks and clay for retorts,			180	0 0
Labor for building retorts,			110	0 0
			£783	0 0
Cost of repairs for 10 years, at 20*s.* per bed per ann.,	£100 0 0			
Less value of old front plates, &c., 20 tons, at 25*s.*,	25 0 0			
			75	0 0
Making the total expense of brick retorts,			£858	0 0

Now, as the quantity of gas that each of the two descriptions of retorts is estimated to generate is the same for 10 years, namely, 1460 millions cubic feet, it follows that the gas from the cast iron retorts costs 9*d.* per 10,000 cubic feet, and that from the fire brick retorts 1⅓*d.* per 10,000 cubic feet, for the item of retorts and ovens; showing an economy of 84 per cent. in the improved fire brick retorts.

Mr. Chellingworth inquired whether a defect in a brick retort could be repaired, such as a bad joint? When an iron retort became broken, it could not be repaired, and was all lost, and had to be pulled out; but it was a great advantage in the brick retorts if they could be readily repaired.

Mr. Clift replied, that a defect could be easily repaired at any time, without stopping the working of the retorts. The surface of the retorts could be thoroughly examined through the different sight holes of the oven, and any defective joint detected by the appearance of a gas flame; and a single brick could be taken out of any part when required, and removed by proper tools through the sight holes, which were made large enough for a brick to pass; and another brick was then set in its place with fire clay, without occasion to let down the heat of the retort. When a brick retort was pulled down, it was found that the carbon deposited from the gas filled up any crack or fracture, by the carbon adhering to the rough surface of the brick and collecting upon it, from the indestructible nature of the brick. But a crack in a cast iron retort continued getting worse, and became constantly more open, on account of the surface of the iron perishing in the sides of the crack, which prevented it from getting closed up by a deposit of carbon, as in the brick retorts. When a cast iron retort was once cracked it was done for, and must be thrown away, requiring the whole oven to be opened out and rebuilt, and causing a serious delay to the work, as well as expense.

Mr. Ramsbottom remarked, that the greater equality in the rate of expansion by heat of carbon and fire brick, than of carbon and cast iron, would probably assist in keeping the joints close.

Mr. Clift observed, that on pulling down the brick retorts, after seven years' working, it was found that the joints were completely blackened, and filled with carbon half way through, up to the fire clay stopping in the centre groove; but the outer half of the joints showed no appearance of the carbon having passed the groove. The plan of constructing the retorts of double the usual length, with a mouth piece at each end, he had only had in use for about a year; but he found it a decided improvement, and had since adopted it in all new works. The other retorts became scurfed up with a large accumulation of carbon, particularly at the back ends, where the scurf became several inches thick, and very hard; and the retorts had to be stopped work, and the heat let down, usually every eight months, for the purpose of clearing out this scurf, and getting it detached by the contraction in cooling. But in the long retorts, open at both ends, there was no back for the scurf to accumulate, and the current of air through the retort, every time that both ends were opened, caused the scurf to scale off, and it was much easier to detach; and consequently, it was found that they would work much longer before requiring to be let down. Also, the centre portion of the oven, which is

the hottest part, and most valuable for making gas, was lost before by the blank ends of the retorts, but is now made available, as there is only a single brick wall dividing the flues; and by this means, the heating surface and contents of the retorts are increased, without any increase in the size or expense. Another advantage is found in preventing the injury and shaking of the joints that was caused in drawing the coke from the retort by the heavy rake being driven against the back of the retort.—*Proc. Inst. Mech. Eng., Birmingham, July 25th*, 1852.

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*Description of the Steamship Arabia.**

Messers. Robert Steele and Co. launched from their building yard on the 21st of June, the steam vessel *Arabia* (late the *Persia*). At the time appointed, ½ past 2, P. M., as the vessel began to move, she was named the *Arabia* by Miss Louisa Myles, daughter of the Rev. Mr. Myles, of Glasgow. Amongst the gentlemen present at the launch were the Messrs. Burns, of Glasgow, Mr. M'Ivor, of Liverpool, &c.

Dimensions.	feet.	tenths.
Length on deck, ...	284	2
Breadth on deck amidships, . .	37	3
Depth of hold amidship, . .	27	6

Tonnage.	tons.
Sectional act, ...	$2393\frac{42}{100}$
Act for foreign vessels, ...	$2250\frac{60}{100}$

A pair of sway-beam engines, by Mr. Robert Napier, Vulcan and Lancefield foundries, Glasgow, of 910 horse (nominal) power; diameter of cylinders, 103 inches × 9 feet length of stroke; diameter of paddle wheels, 37 feet; having tubular boilers, and 2 funnels, &c.

The builders have taken a hint from Brother Jonathan, and moulded the *Arabia* sharper forward than any of the Company's vessels that have been previously built, and the after run is probably one of the finest and most elegant series of curves, from a vertical straight line to a long flat floor and full round bilges, ever seen. The desiderata of a fine entrance and run have been attained, consistently with large available space and tonnage, owing to the great length, which is seven times the breadth, while there is ample space for a midship line, without injuring the easy curves at either extremity, so requisite to ensure fast sailing. From the great length, and the immense weight of the machinery to be put on board, she required to be more than usually rigid. This extra strength has been attained by two series of diagonal iron bracing, extending from the main deck beams down to the bilges. The braces are bolted by through bolts to every timber which they cross. The first series of braces are sunk or checked flush into the timber, the second series lying over them. No amount or disposition of timber could possibly give the strength or rigidity which this complete system of iron bracing effects.

The sleeping accommodations are all arranged under the main deck, and extend the whole length of the vessel fore and aft. There are two

* From the London Artizan for September, 1852.

berths to every state room, placed fore and aft, an advantage and comfort which voyagers alone can fully appreciate. The state rooms are thoroughly ventilated by spacious louvres, fitted with glass, opening into the passages, and they communicate, in their whole length, with the open air above, through a continuous lateral opening under the seats on each side of the saloon on deck. The saloon extends the whole length of the vessel, affording an unbroken promenade from stem to stern. This is a great improvement upon the detached houses on deck, as hitherto adopted, and affords a vastly increased accommodation, without interfering with the ship-shape of the vessel, or the requisite facilities for handling or working her. The *Arabia* is owned by the British and North American Royal Mail Steam Navigation Company, and is to ply between Liverpool and New York.

DESCRIPTION.

A bust female figure head, no galleries, round sterned, and carvel built vessel, three decks (flush), stationary bowsprit, two masts, brig-rigged, port of Glasgow. Commander, Mr. Charles Henry Evans Judkins. Arrived at Lancefield Quay, Glasgow, from Greenock, to receive the machinery, &c.

For the Journal of the Franklin Institute.

The Caloric Engine.

The past month has witnessed the trial of an experiment to which the engineering world has looked forward with an unusual degree of interest, due, perhaps, as much to the boldness of the attempt as to the influence its success was expected to produce on the progress of the Mechanic Arts. Curiosity had been still further stimulated by the jealous care exercised in preventing the visits of strangers to watch the progress of the experiment, and by the air of mystery in which the whole affair was enveloped.

At length, however, the veil has been removed. On the 15th day of December, 1852, the engines of the *Ericsson* were put in motion by the power of compressed air, and two trials have since been made in New York harbor on the 4th and 11th January, 1853. The performance of the engines and speed of the ship on those trials have been reported by the newspapers in statements of a nature so contradictory and extravagant, that those who desire to form a judgment respecting the ultimate success of the enterprise, find it difficult to obtain from those sources the requisite data. By a little inquiry, however, we have ascertained the facts which were then observed, and believe the following account of them to be deserving of credit. We propose, after giving that account, to discuss the question, "whether atmospheric air can supersede steam as a motive power in the propulsion of ships?"

We shall, in the first place, describe briefly the principles of construction and operation of the caloric engine, referring those of our readers who desire further information, to a statement embodying the specification and patent claim which appeared in this Journal in October, 1851, (vol. xxii. pp. 229–231.)

Two cylinders of different diameters are placed one above the other, their inner ends open to the atmosphere, and are provided with pistons connected together; the smaller one (above) is termed the *supply*, and the other the *working* cylinder. A vessel called a receiver, of a volume at least equal to the former of these, and another termed a regenerator, containing a large quantity of wire cloth or other metallic substances presenting an extended surface, are connected with the cylinders in such manner, that all air passing *from* the supply must pass through the receiver on its way to the working cylinder, and that all air either entering or leaving the working cylinder must go through the regenerator. A self-acting valve in the piston, opening inwardly, permits the entrance of air from the atmosphere to the upper end of the supply cylinder, (the lower end being open.) A self-acting valve opening outwardly governs the passage from the supply cylinder to the receiver. And other valves are so placed as to regulate the passage of air to or from the lower end of the working cylinder. A furnace is built beneath this latter, in which is consumed all the fuel required for propulsion.

It will be understood that the supply cylinder is merely a pump to supply the other with air; that the receiver is a sort of magazine for the storage of this air when compressed by the pump; that this air is expanded in volume by heat, so as to maintain it at the same pressure, while filling the superior capacity of the working cylinder; and that the regenerator is a magazine in which is stored the heat given out by the hot air escaping, to be given back to the cold air, going into the working cylinder to perform the next stroke. Finally, that with a limit of temperature and point of cutting off, the size of the supply cylinder governs the pressure of air at which the engine is worked. The operation of the machine is as follows:

The pistons being at the bottom of the stroke, air is pumped into the receiver until it has the desired pressure. A fire having been kindled under the working cylinder, this air becomes expanded and the piston ascends, pushing before it the supply piston, which at some point in the stroke (depending on the pressure in the receiver), compresses the air above it so as to open the valve into the receiver; this continues open till the termination of the stroke. Meantime, the inlet valve of the working cylinder being open, the latter is taking from the receiver a volume of air equal to that forced in it by the supply piston. But in its passage along he heated surfaces, the temperature is raised and its volume therefore expanded so as to retain its initial pressure, and yet fill the greater displacement under the working piston. Arrived at the top of the stroke, the outlet valve of the working cylinder is opened, the pistons descend by gravity, and the air escaping through the regenerator leaves a portion of its heat. When the pistons again reach the lowest point of their movement, the outlet valve is closed—and on the inlet valve being opened, the air stored in the receiver again passes through the regenerator into the working cylinder, taking up in its passage the heat remaining in the wire cloth—and so the engine continues to perform its functions. The furnace under the cylinder is merely for the purpose of supplying that part of the heat which the regenerator will not take up. The powers of this

latter, therefore, are an index of the economy of the machine. The flow of air into the working cylinder may be cut off at any part of the stroke.

The advantages claimed for this method of obtaining power are numerous, but there are three which, from their importance, deserve serious consideration. They are—

1st. Economy of fuel, amounting to about $\frac{9}{10}$ths of that ordinarily required to develop equal power with steam.

2d. Economy of space required for the machinery and the coal necessary for a voyage.

3d. Superior safety from the diminished risk of fire and explosion.

After giving the dimensions of the ship and engines, and the results noted on the trial, these will be considered seriatim.

Proportions of Hull.—The *Ericsson* is a vessel of 250 feet in length, 40 feet beam, and 22 feet 6 inches hold, built in the strongest manner, of beautiful mould and finish, and said to possess every qualification for great speed; constructed expressly for the purpose of trying Capt. Ericsson's engines.

Draft of water on trial, 16 feet 9 inches, with her machinery and 200 tons pig iron on board.

Proportions of Engines.—The engines have four working cylinders 168 inches in diameter, 6 feet stroke; 4 supply do., 137 inches in diameter, 6 feet stroke, and are placed two forward and two abaft the shaft; both pairs connected to one crank pin by connecting rods attached to lever beams, to which also the pistons are connected by links, &c. Her working pistons are hollow, about six feet deep, and filled with non-conducting substances. Packing is on the upper side, and never rubs on surface directly exposed to the heat. The working cylinders have beneath them receptacles filled by the pistons at the lowest point of the stroke, the bottom and sides of which are exposed to the fire in the furnaces beneath. Space occupied by the machinery 76 feet long, 19 broad, and the whole depth of the ship; height of top of engine 30 feet above kelson.

Wheels.—The side wheels are 32 feet outside diameter, 10 feet face, effective diameter 30 feet 9 inches.

Two smoke pipes and two ventilators, each 30 inches in diameter, appear above decks in lieu of the usual funnels.

Trials.—The first one was about four hours in duration, the last some $2\frac{3}{4}$ hours. Revolutions obtained, $10\frac{1}{2}$ per minute; pressure of air, 8 pounds per square inch; cut-off at $\frac{2}{3}$ the up-stroke; consumption of fuel, 550 lbs. per hour; kind of fuel, anthracite coal, (the rumor that *charcoal* was used is without foundation;) speed reported, 8 statute miles per hour. This is the element most liable to error. It will hereafter be seen that from reasons which appear to be just, we place her speed at $8\frac{7}{8}$ miles per hour as a maximum. It is quite certain that this latter was not exceeded.

We shall now consider the advantages previously claimed, and premise that in the following comparisons, the Collins steamers are taken as an index of what has been done in steam navigation, and what must be done again in order to ensure passenger traffic across the Atlantic. And further, that the friction of the caloric engine has been estimated as only equalling that of a steam engine, (and the air pump resistance,) whereas it would in all probability be much greater.

Economy of Fuel.—Knowing the consumption on board the *Ericsson*, the first step in a comparison to determine this point is to calculate the size and consumption of steam engines developing the same force. The working cylinder of a caloric engine, as now made, bears to that of a steam engine—

1st. As being single instead of double acting, 2 to 1

2d. As having only $\frac{1}{3}$ of its area effective, owing to that of the supply cylinder being $\frac{2}{3}$, 3 to 1

3d. As using a pressure of 8 pounds,* while in Collins' steamers is obtained 16 pounds cylinder pressure, 12½ vacuum, cutting off at $\frac{1}{3}$ = 19·25 pounds effective pressure, 2·406 to 1

A proportion equivalent to $(2 \times 3 \times 2{\cdot}406)$ = 14·436 to 1

Now, the *Ericsson's* working cylinder capacity consists of 4 of 168 inches by 6 feet, having a collective stroke displacement of 3696 cubic feet. Therefore, the steam cylinder must have $\frac{3696}{14{\cdot}436}$ = 256 cubic feet capacity, which, cutting off at $\frac{1}{3}$ in two single strokes, gives $\frac{256 \times 2}{3}$ = 170·67 $\times 60 \times 10\frac{1}{2}$ revolutions = 107522 cubic feet steam per hour, or (at 853 = volume of steam at 16 pounds) = $\frac{107522}{853}$ = $126 \times 64\frac{1}{3}$ = 8106 pounds of water per hour, requiring a combustion of $\frac{8106}{7{\cdot}54}$ = 1075 pounds per hr.

(See page 42, last number of the *Journal*.) That of the *Ericsson* was 550 lbs., or 51 per cent. of the above.

But upon the trials, the leakage of air is stated to have been great, owing to the action of the heat on the lower valves and seats, and to the unequal expansion of the working cylinder during the operation of the engine, its lower diameter having increased one-half inch more than the upper diameter; and as there was not enough elasticity in the piston springs to push out the packing, the leakage at the lower part of the stroke was considerable.†

* The pressure above the supply piston commences at 0, and only arrives at 8 lbs. at ⅔ of the up stroke, which is equivalent to cutting it off at ⅔; the working pressure is 8 lbs., which was cut off at ⅔-stroke. Hence, the working pressure *effective* was 8 lbs. acting during ⅔ the stroke = 7·56 lbs. per square inch on the difference of areas of the working and supply pistons.

† To determine the leakage.

Let the volume of the working cylinder be represented by $\left.\begin{matrix} V \\ \frac{2V}{3} \end{matrix}\right\}$ then

" " " supply " "

as the air in the receiver was at a pressure of 8 lbs. the volume $\frac{2V}{3}$ at atmospheric pressure, became in the receiver a volume of $\frac{2V}{3} \times \frac{15}{15+8}$ = 0·434 V, at a pressure of 8 lbs.; and if this were doubled in volume, (involving a heat of something like 493° Fahr.,) which is probably an extreme case, it could follow the piston so as to occupy a capacity of (0·434 × 2) V = 0·868 V, while it was actually cut off on the trial at $\frac{2}{3}$ V = ·667 V. Hence we may take the whole leakage at (0·868 — 0·667) V = 20 per cent.

On the presumption that the temperature to which the air was raised did not exceed that required to double its volume at 60°, this leakage might have amounted to 20 per cent. of the whole working cylinder, or $\frac{\cdot 20}{\cdot 67}$ = 30 per cent. of that actually used. Should the *whole* of this be in future overcome, either the pressure would be slightly increased with the same consumption, or the fuel would be reduced, the pressure remaining the same, in the proportion of 1·30 to 1·00, or from 550 to 423 pounds per hour—at which, in this comparison, it will be taken. This would be equal to nearly 40 per cent. of that of a steam engine.

The difference between this amount of fuel (423) and the amount required by calculation (108) to raise the volume of 1,548,240 cubic feet = 120,920 pounds of air 30° the amount not to be returned by the regenerator, is enormous, being nearly 4 to 1; and it is probably owing in part to the radiation from the heated parts, and principally to the imperfect operation of the regenerator.

As to the economy in working, we have no account of the amount of lubricating material to be used in warm cylinders, having nearly 1000 square feet of surface to be kept greased.

Economy of Space.—We have now to consider the second advantage claimed, which is partially estimated on the reduction in amount of fuel for a transatlantic voyage, as occupying more room than that required by the new engine; and begin by a calculation of the power required to drive the *Ericsson* on the ocean at a speed equal to that of the Collins steamers. A few figures will show that to obtain this power in the *Ericsson*, her caloric engines would have to be increased to a size rendering the justice of this claim doubtful.

The Collins steamers will make at the termination of a voyage (in New York harbor), 13½ geographical = 15·55 statute miles per hour, with the steam pressure above taken, and making 17 turns per minute of a wheel 33 feet 3 inches effective diameter. At the same slip, the wheels of the *Ericsson*, making 10½ revolutions of 30¾ feet effective diameter, should have driven her 8·873 miles per hour, which we shall allow as her actual speed. That this speed is inadequate for transatlantic navigation, will be readily seen from the following comparison. (Refer to page 42, present volume, for performance of the *Arctic*.)

Collins steamers make in still water,	15·55	statute miles per hour.
" " on an average of 3190 hours steaming, a mean speed of	13·44	" "
Reduction of speed by weather, &c.,	2·11	
Speed of the Ericsson in New York Harbor,	8·87	" "
Deduct as above,	2·11	
Average speed to be expected,	6·76	" "

The mean of 12 passages between New York and Liverpool, gives as the distance 3080 geographical miles (of 6082⅔ feet,) = 3548 statute miles. At the rate of 6¾ miles per hour, this would require 524 hours = 21 days 20 hours length of passage, which is not less than the average trips of the clipper ships.

To obtain 15·55 miles with the *Ericsson* would require $18\frac{3}{8}$ revolutions per minute. Now the power required to drive a vessel is as the cube of the speed—therefore, to make this latter speed would require $\frac{(15{\cdot}55)^3}{(8{\cdot}373)^3} = 5{\cdot}375$ times the power actually developed on the trial. Unless the working pressure were increased, which could not be done without augmenting the area of supply cylinders, and consequent back pressure; or the temperature which would destroy the cylinder bottoms with a rapidity in a far higher ratio than that of the increase of heat; or by cutting off shorter, (thereby slightly augmenting the initial pressure,) which would involve a higher per centage of leakage; the capacity of cylinder developed per minute must be increased 5·375 times, or would have to be $\frac{3696 \times 10\frac{1}{2} \text{ revs.}}{18{\cdot}375 \text{ revs.}} \times 5{\cdot}375 = 11341$ cubic feet, or with the same stroke, (6 feet,) = 1890 square feet collective area, equal to four cylinders 24 feet 6 inches diameter, with supply cylinders 20 feet 2 inches diameter.

The consumption of fuel would be $423 \times 5\frac{3}{8} = 2279$ pounds per hour $= 24\frac{3}{8}$ tons per diem.

The same work could be done by two 90 inch × 8 feet cylinders* with the above pressure and revolutions, and the consumption of fuel would be about 5000 pounds an hour = 60 tons a day. The coal saved in a trip of $12\frac{1}{2}$ days would therefore be $35\frac{5}{8} \times 12\frac{1}{2} = 445$ tons occupying 15,575 cubic feet.

Now a pair of 90's × 8, oscillators, could be very readily put into an area of 30×15=450 sq. ft., which by the whole depth of ship is $450 \times 22\frac{1}{2}$ = 10,125 cu. ft.,
and tubular boilers like those of the *Golden Gate*, with fire room between, into an area of 34×32×14 deep = 15,232 "
while the extra coal space required is 15,575 "

Total, . . 40,932 "

Four caloric engines $24\frac{1}{2} \times 6$ feet would require an area of *at least* 115 feet in the length of the ship, and 30 feet in width, which by the whole depth (throwing off the projection above deck) $22\frac{1}{2}$ gives $115 \times 30 \times 22\frac{1}{2} = 77625$, or more than $1\frac{7}{8}$ times the space required for steam engines of equal power.

Safety.—As regards safety, the chances would be decidedly in favor of the new plan. Experience, however, does not show that this advantage, or that of cheapness in passage, (owing to economy of fuel,) is properly appreciated when accompanied by reduced speed; and it is very doubtful whether engines of the size above named *could*, or would be put into a ship of the *Ericsson's* dimensions, in which case her speed would undoubtedly be too slow to ensure popularity.

We have seen, then,

1st, That a saving of fuel of 60 per cent. may be effected.

2d, But that the space required would be 90 per cent. more than

* The Steamer *Georgia* is $248\frac{3}{4}$ feet long, 48 feet 8 inches beam, and has two 90 inch cylinders 8 feet, which with a less pressure than we have allowed above, drive the ship at about the same speed as that estimated for.

that occupied by steam engines, boilers, and the saving of coal. In addition to which it must be recollected that in our comparison, the caloric engines were developing nearly their full power, while the steam engines were cutting off at one-third stroke; consequently, in heavy weather, a very slight increase of pressure on the pistons could be relied on in the former. The capability of following steam the whole stroke in a gale of wind ahead, is of material advantage to ocean steamers.

As to river steamers, the difference of space and weight becomes even greater, as the amount of coal to be carried is trifling.

We think the inference must be drawn from the foregoing, that unless some material change is made in the caloric engine as at present constructed, it is highly improbable that it will ever take the place of steam engines on fast steamers; and as regards freighting vessels, that clippers making average passages of 20 to 25 days across the Atlantic, will probably not be superseded by vessels in which so large a space is taken up by machinery and coal, of which the expenses of running and wear and tear cannot be insignificant, and whose passages will not be averaged in less time.

This inference, however, it must be recollected, does not involve the failure of the object held in view in the construction of the *Ericsson*. That object we presume was to show that by certain peculiarities of construction introduced by Capt. Ericsson, into the engines hitherto used with air, their permanent or continuous operation might be secured, so that the mechanical difficulties (such as heavy losses from friction and leakage, rapid oxydation of metal, &c.,) which have hitherto prevented that class of engines from extended use in practice, might be removed. That question cannot be decided in a few hours; it is the work of time with its usual experience,—and if that experience shall show that the object above alluded to has been accomplished, it is not impossible that *the Caloric Engine* may be extensively employed in pumping or drainage, or in the many branches of manufacture where economy of fuel is the grand consideration, and there is no limit to the space or weight of the machinery to be employed.

In view of these great manufacturing interests to which the benefits of Capt. Ericsson's invention would accrue, it is earnestly to be hoped that time will show the justice of his long continued confidence in his favorite project. M.

For the Journal of the Franklin Institute.

Notes on the United States Steamship Powhatan. By B. F. Isherwood, Chief Engineer, U. S. Navy.

(*With a Plate.*)

The *Powhatan* is a very similar steamship to the *Susquehanna*, an account of whose performance is given in the last October number of this *Journal*. The return of the *Powhatan* from her first few months' cruising, afforded me the opportunity of obtaining her exact performance from the steam log, which I have tabulated for brevity, and in which I have given separately the means for each number of consecutive hours,

where the weather, sail, cut-off, &c., remained unchanged. This table contains *all* the steaming done.

The engines of the *Powhatan* and *Susquehanna*, are of the same type, inclined and direct acting; they have cylinders of the same diameter and stroke of piston, and differ from each other in details only. They both cut off by the steam valves, which are of the double puppet kind; Sickels' arrangement for cutting off being used in the *Powhatan*, and Stevens' in the *Susquehanna*.

The hulls of the *Powhatan* and *Susquehanna*, though of the same linear dimensions, have very different water lines. The bow of the *Powhatan* is much sharper than the *Susquehanna's*, while the stern of the latter ship is much finer. The two ends, or rather the fore and after body of the *Powhatan*, are exactly alike, the dead flat being at the centre of the water line, while the model of the *Susquehanna* more nearly resembles that of a sailing vessel, with bow fuller than stern, and dead flat placed forward of the centre of the water line. Both vessels are sparred alike and spread equal amounts of canvass, viz: 21,230 square feet.

HULL.

Length on deck,	251 ft. 6 inches.
Length on water line at 18 feet 6 inches mean draft,	249 " 9 "
Length for Custom House measurement,	251 "
Length on keel,	246 "
Beam on deck, extreme,	45 "
Depth of hold,	26 " 6 "
Height between berth and spar decks in clear of beams,	6 " 9 "
Depth of keel and false keel,	1 " 6 "
Mean draft of water at launching,	10·62 feet.
Actual displacement at launching,	1585 tons.
Calculated displacement at launching,	1600 "
Angle of entrance at 17 feet 6 inches draft,	48°
Angle of entrance at 19 feet 6 inches draft,	54° 40′

Displacements and Areas of Immersed Amidship Sections at the following drafts of Water.

Mean drafts of vessel, including keel.	Immersed amidship Sections.	Displacements.
Ft. In.	Sq. Ft.	Tons (2240 lbs.) of sea water.
15 6	528·	2821·
17 2	603·	3249·3
17 6	618·	3335·
18 0	640·5	3467·5
18 6	663·	3600·
19 0	685·5	3732·5
19 6	708·	3865·

At 18 feet 6 inches draft of water, the centre of displacement below water line is 8·86 feet; and the height of the metacentre above the centre of gravity of displacement is 10.87 feet. The position of the centre of displacement is, as has been before stated, exactly at the centre of the water line.

By a comparison of the above with the corresponding items of the *Susquehanna's* hull, it will be seen that at 17 feet 6 inches draft from bot-

tom of keel, the displacement of the *Powhatan* exceeds that of the *Susquehanna* by 58 tons, or about 1·77 per centum of the latter. The immersed amidship section of the *Susquehanna* at the above draft is 21 square feet, or 3·4 per centum greater than the *Powhatan's*. At 19 feet 6 inches draft, the same difference of 21 square feet holds with the immersed amidship section, but the displacement of the *Powhatan now exceeds* that of the *Susquehanna* by 41 tons. At 19 feet 6 inches draft, the *Susquehanna's* displacement per inch of draft is 23 tons, while the *Powhatan's* is $22\frac{1}{2}$ tons. It thus appears the *Susquehanna* has the greater capacity at the load line, while the *Powhatan* has the greater capacity in the lower lines; which also follows from the fact that the centre of displacement in the *Susquehanna* at 18 feet 6 inches draft is 7·167 feet below the water line, while in the *Powhatan*, at the same draft, it is 8·86 feet below the water line, or 1·693 foot lower; also the height of the metacentre above the centre of gravity of the displacement in the *Susquehanna* at 18 feet 6 inches draft is 11·208 feet, while in the *Powhatan* it is 10·87 feet, or 0·338 foot lower.

ENGINES.—Two inclined, direct acting, condensing engines.

Diameter of cylinders,	70 inches.
Stroke of piston,	10 feet.
Diameter of the disks of the steam valves,	$14\frac{3}{4}$ and 16 inches.
Diameter of the disks of the exhaust valves,	$15\frac{1}{2}$ and $16\frac{1}{2}$ "
Space displacement of both pistons per stroke,	534·51 cubic feet.
Steam space between cut-off valve and pistons, at one end of both cylinders,	26. "

PADDLE WHEELS, of the common radial kind.

Diameter from outside to outside of paddles,	31 feet.
Length of paddles,	10 "
Width of paddles, $\frac{7}{8}$	26 inches,
Area of two paddles,	$43\frac{1}{2}$ square feet.
Number of paddles in each wheel,	23
Number of paddles in each wheel in water at 18 ft. draft,	5
Immersion of lower edge of paddles at 18 ft. draft of water,	4 feet 11 inches.

BOILERS.—(Plate III.)—Four copper boilers with double return ascending flues.

Length of each boiler,	16 feet.
Breadth of each boiler,	15 " 3 inches.
Height of each boiler, (exclusive of steam chimney,)	13 "
Total area of heating surface in the four boilers,	7706 square feet.
Total area of grate surface in the four boilers,	356 "
Aggregate cross area of the first row of flues in the four boilers,	75·720 "
Aggregate cross area of the second and third row of flues in the four boilers, (each row),	55·906 "
Cross area of the smoke chimney,	63·617 "
Height of the smoke chimney above the grates,	65 feet.
Weight of the four boilers and appurtenances,	199·75 tons.
Weight of sea water in the four boilers, (calculated,)	84·38 "

The total length occupied in the vessel by machinery from bulkhead to bulkhead, is the same as in the *Susquehanna*, 102 feet 9 inches; but the bunkers stow only 800 tons of coal, being 100 tons less than the *Susquehanna*, owing to the steam pipes of the *Powhatan*, two in number, being carried through the side bunkers, while in the *Susquehanna* the single steam pipe is carried between the engines.

Table of the Performance of the U. S. Steamship Powhatan, under steam assisted by sail.

DATE, 1862.	Number of consecutive hours.	Speed of the vessel per hour, in knots of 6082⅔ feet.	Course of the Vessel.	WIND. Direction.	WIND. Kind.	Sail.	Sea.	Mean draft of vessel.	Immersion of lower edge of paddles.	Slip of the centre of pressure of the paddles in per cents. of its speed.	ENGINES. Steam pressure in boiler per square inch above atmos.	Double strokes of piston per minute.	Steam cut off at from commencement of stroke.	Proportion of throttle open.	Back pressure in condenser per gauge.	Cumberland bituminous coal consumed per h'r.
								ft. in.	ft. in.	per ct.	lbs.		ins.		lbs.	lbs.
Oct. 16 and 17.	17	9·455	S. by W.	N. W. or on quarter.	Mod. breeze	Fore and Aft and mainsail	Smooth.	19 7	6 6	10·48	13·5	12·800	60	·36	21	4538
Oct 20, 21, 22.	72	10·820	S. W.	N. or on quarter.	" "	Top gallant.	"	18 7	5 6	8·73	10·5	12·927	60	5-16	21	4456
Oct 28, 29.	24	10·835	W. by S.	E. S. E. or on quarter.	Light wind.	Topsails.	"	18 2	5 1	5·88	8·6	12·473	60	·35	21	3590
Oct. 31.	9	11·500	S. W.	N. N. W. or on quarter.	Light breeze	"	"	17 10	4 9	3·94	11·5	13·650	33	·5	21	3900
Oct 31.	9	11·778	S. W.	N. W. or on quarter.	" "	"	"	17 10	4 9	6·65	13·3	13·907	50	·5	21	3900
Oct 31 & Nov. 1	10	10·650	S. W.	N. W. or on quarter.	Gentle br'ze	"	"	17 7	4 6	10·60	13·1	12·900	33	·5	21	3487
Nov 2.	4	9·750	N. N. E.	E. by S. or abeam.	Fresh wind.	Fore and aft.	Moderate.	17 5	4 4	6·36	10·9	11·350	33	·5	21	2625
Nov. 3.	20	10·150	N. N. E.	" " "	" "	" "	"	17 5	4 4	6·75	9·1	11·895	60	·5	21	2908
Nov. 4.	12	9·417	N. N. E.	" " "	" "	" "	"	17 5	4 4	3·24	9·8	10·620	40	·5	21	2580
Nov 4 and 5.	24	10·792	N. by E.	S. and E. or on quarter.	" "	Topsails.	Rough.	17 2	4 3	6·79	7·8	12·483	60	·5	21	2828
Nov. 5	5	10·000	N. by E.	" " "	" "	" "	"	17 2	4 1	12·99	11·2	11·400	40	·5	21	2805
Nov. 19, 20.	10	9·250	S. E.	N. E or on quarter.	" "	" "	Smooth.	18 6	5 4	2·86	8·5	10·380	60	·5	21	2490
Nov. 25.	12	10·083	N. W.	S. E. or aft.	Light breeze	" "	"	18 1	5 0	27·81	8·5	15·225	60	·35	21	4490
Means,	223	10·473						18 1	5 0	9·25	10·1	12·606	56	·372	21	3665

Performance under steam unassisted by sail.

Oct. 17, 18, 19.	60	9·925	S. W.	S. S. West or on bows.	Light wind.	None.	Smooth.	19 1	6 0	15·59	12·5	12·943	60	5-16	21	4990
Oct. 20.	8	9·625	W. S. W.	S. and W. or on bows.	" "	"	Moderate.	18 1	5 6	10·15	10·6	11·675	60	·5	21	3500
Oct. 29 and 30.	12	9·917	W. S. W.	S. and W. or on bow.	" "	"	"	17 11	4 10	13·48	7·4	8·811	20	·5	21	2590
Oct. 30.	4	8·000	W. S. W.	N. W. or abeam.	" "	"	"	17 11	4 10	29·60	10·6	11·800	60	·5	21	3340
Oct. 30 and 31	20	9·500	. . .	Abeam.	Mod wind.	"	"	17 10	4 9	6·15	10·0	11·035	50	·5	21	3583
Nov. 1 and 2.	21	10·452	. . .	On bow.	Gentle bree.	"	Smooth.	17 6	4 5	15·39	9·7	13·407	60	·5	21	3317
Nov. 6 and 7.	12	8·917	N. N. E.	S. E. or abeam.	Mod. breeze.	"	Moderate.	17 5	4 4	16·40	10·1	11·020	40	·5	21	2485
Nov. 21 and 22	24	10·292	S. E.	E. N. E. or abeam.	Fresh wind	"	"	18 2	5 1	16·40	11·6	13·417	60	·5	21	4424
Nov. 23, 24, 25.	60	10·400	N. E.	N. and E. or on bow.	Light breeze.	"	Smooth.	17 8	4 7	20·70	9·0	14·293	60	·35	21	4462
Means,	221	9·979						18 1	5 0	16·45	10·4	12·627	56	·392	21	3951

The mean results from the above log would compare as follows, viz:

Comparative performance of the Powhatan, under steam and sail, and under steam alone.

	Assisted by sail.	Unassisted by sail.
Total number of hours,	223	221
Speed of vessel per hour in knots of 6082⅔ feet,	10·474	9·679
Mean draft of vessel,	18 ft 1 in.	18 ft. 1 in.
Immersion of lower edge of paddle,	5 ft	5 ft.
Slip of the centre of pressure of the paddles in per cents. of its speed,	9·25	16.45
Oblique action of the paddle,	18·48	18·48
Steam pressure in boilers per gauge, per square inch above atmosphere in pounds,	10·1	10·4
Steam pressure in cylinders per square inch above atmosphere, in pounds,	6·1	6·4
Double strokes of piston made per minute,	12·600	12·627
Part of stroke of piston, steam cut-off at from commencement in inches,	56	56
Proportion of throttle valve open,	·273	·292
Back pressure in condenser per gauge in pounds,	2	2
Mean effective pressure per square inch of piston in pounds,	13·35	13·6
Horses power developed by the engines,	784·7	801·1
Pounds of Cumberland bituminous coal burned per hour,	3665	3951
Tons of 2240 pounds of Cumberland bituminous coal burned per 24 hours,	39·27	42·33
Pounds of steam evaporated per hour from sea water of twice the natural concentration, by one pound of coal, with the temperature of feed water, 100° F., including the waste by filling the cylinder nozzles and clearance, and by blowing off to maintain the sea water at twice the natural concentration,	6·511	6·135
	Moderate breeze abaft the beam, and moderate sea.	Gentle breeze forward the beam and smooth sea.

Remarks on the preceding Log.

The speed of the vessel (taken by the chip log) comprised in that portion of the table under the head of "performance under steam unassisted by sail," has probably been a little overlogged. This opinion may be arrived at by a comparison of the size of the hull with the size and immersion of the paddles in connexion with their *slip*, the average of which by the log is only 16·45 per centum, whereas it could not have been less than 20 per centum. If the latter slip be taken, the speed of the vessel will be reduced from 9·679 knots to 9·267 knots.

The performance of the engines and boilers may be depended on, the double strokes of piston being taken by a counter, and the point of cutting off ascertained by an indicator applied at both ends of each cylinder. The amount of coal burned is also probably very near the truth; all the furnaces were kept in operation.

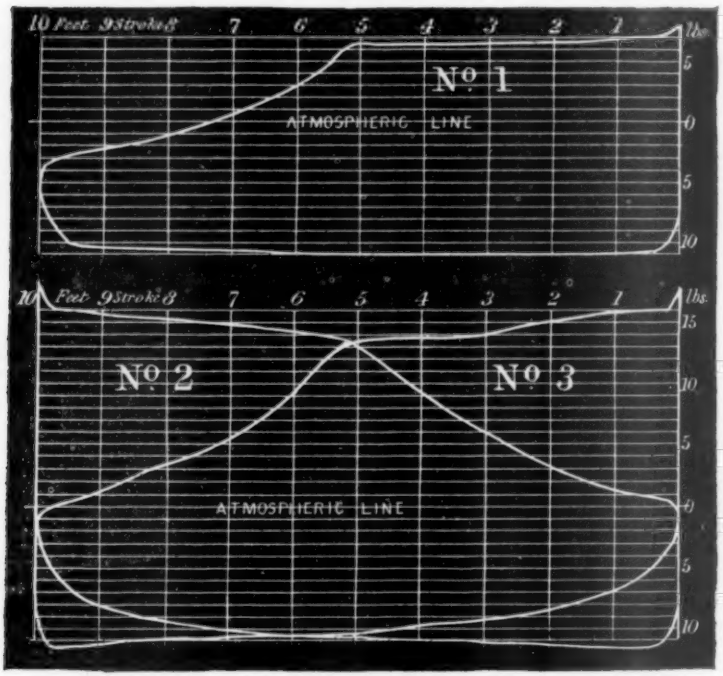
The steaming recorded in the preceding log comprises the run from New York to Havana, from Havana to Vera Cruz, from Vera Cruz to Pensacola, and from Pensacola to Norfolk, Va. During the whole time there was fine weather and smooth seas.

The evaporation by the boilers has been calculated from the number

of cylinder charges of steam, using the data furnished by Regnault's experiments for the latent heat of steam. The difference in the evaporation in the two cases is nearly 6 per centum of the greater, an amount within the limits of errors of observation, enhanced also by the greater rapidity of the combustion in the case giving the lesser result, as with bituminous coal increased rapidity of combustion is attended with decided effect. The temperature of the engine room appears to have averaged 20° above that of the deck.

Indicator Diagrams.

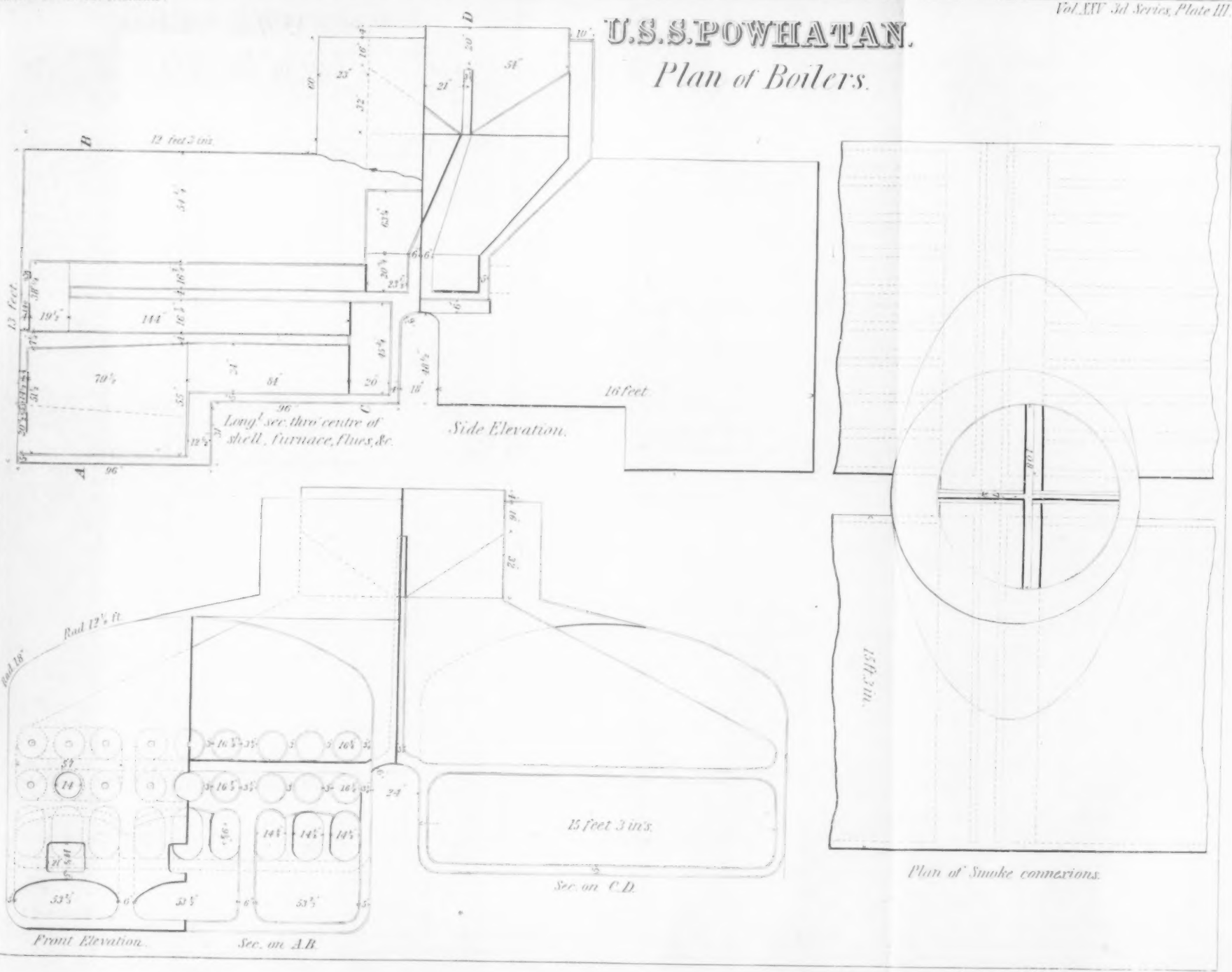
No. 1 was taken November 25th; steam pressure in boiler per gauge, $7\frac{1}{2}$ pounds per square inch above atmosphere; back pressure in condenser per gauge, $1\frac{1}{4}$ pounds per square inch; temperature of hot well, 100° F., throttle, $\frac{5}{8}$ths open; double stroke of piston per minute, 13.



Nos. 2 and 3 were taken from both ends of the same cylinder, November 20th; steam pressure in boiler per gauge, 21 pounds per square inch above atmosphere; back pressure in condenser per gauge, $1\frac{3}{4}$ pounds per square inch; temperature of hot well, 115° F.; throttle, $\frac{5}{8}$ths open; double strokes of piston per minute, $17\frac{1}{4}$; speed of vessel, $12\frac{1}{2}$ knots per hour by chip log; consumption of Cumberland bituminous coal per hour, 5000 pounds; draft of vessel, 17 feet 10 inches forward, and 18 feet 4 inches aft; immersion of lower edge of paddles, 5 feet; slip of the centre of pressure of the paddles, 21 per centum of its speed. Fresh wind on port bow, moderate sea, and no sail set.

U.S.S. POWHATAN.

Plan of Boilers.



Statistics of the Machinery of the U. S. Steamship Powhatan.

	Weight of materials in a finished state.	Finished surfaces.	Days' labor.	Cost.
	Pounds.	Sq. In.	No. days.	$ cts.
ENGINES, complete, including packing, engine room floor, &c.				
Cast iron, . . 262,011 lbs.				
Wrought iron, . 171,761 "				
Steel, . . . 996 "				
Copper, . . . 8,084 "				
	491,282			
Turning and boring, 545,515 sq. in.				
Planing, . . . 133,757 "				
		679,272		
Finishers, . . 37,406 days.				
Pattern makers, . 2,418 "				
Laborers, . . . 11,268 "				
			51,092	
Total cost, . . .				187,091·84
BOILERS.				
Boiler plates and bolts, 311,895 lbs.				
Brass, . . . 13,082 "				
	324,977			
Total cost, . . .				106,964·50
Boiler appurtenances, viz: smoke chimney, steam, feed, discharge, and escape pipes; feed, check, safety, blow, and stop valves; fire room flooring, grate bars, and bearers; furnace, and flue doors; Worthington pumps, drip pans, &c.				
Cast iron, . . 57,913 lbs.				
Wrought iron, . 22,987 "				
Lead, . . . 2,550 "				
Brass, . . . 17,647 "				
Copper, . . 21,358 "				
	122,455			
Finishers, . . 1,647 days.				
Pattern makers, . 963 "				
Laborers, . . 277 "			2,867	
Turning and boring, . 40,155 sq. in.				
Planing, . . 416 "				
		40,571		
Total cost, . . .				28,115·70
COAL BUNKERS, including doors, braces, deck plates, water cocks, &c.				
Cast iron, . . 2,097 lbs.				
Wrought iron, . . 114,900 "				
Brass, . . 275 "				
Copper, . . . 95 "				
	117,367			
Finishers, . . 118 days.				
Laborers, . . . 23 "				
			141	
Planing and turning, 934 sq. in.		934		
Total cost, . . .				13,984·00
Carried up,	1,056,081	720,777	54,100	336,156·04

	Weight of materials in a finished state.	Finished surfaces.	Days' labor.	Cost.
	Pounds.	Sq. In.	No. days.	$ cts.
Amount brought over, . .	1,056,081	720,777	54,100	336,156·04
PADDLE WHEELS.—Centres, arms, and rims only.				
Cast iron, . . 21,364 lbs.				
Wrought iron, . . 75,865 "				
	97,499			
Finishers, . . . 173 days.				
Pattern makers, . 116 "				
			289	
Planing, . . . 22,550 sq. in.				
		22,550		
Total cost, . . .				11,858·37
EXTRA PIECES, engine fixtures, &c.				
Cast iron, . . 27,010 lbs.				
Wrought iron, . . 17,741 "				
Brass, . . . 5,384 "				
	50,135			
Finishers, . . 1,164 days.				
Pattern makers, . . 2 "				
Laborers, . . 170 "				
			1,336	
Turning and boring, 15,273 sq. in.				
Planing, . . . 16,100 "				
		31,573		
Total cost, . . .				13,383·88
HOISTING ENGINE AND BOILER.				
Wrought iron, . 436 lbs.				
Cast iron, . . . 1,435 "				
Brass, . . . 2,310 "				
Copper, . . . 388 "				
	4,569			
Boiler makers, . . 441 days.				
Finishers, . . 30 "				
Pattern makers, . 26 "				
			497	
Turning and boring, 441 sq. in.				
		441		
Total cost, . . .				3,040·78
Pine in all patterns, . . .				902·19
	1,208,304	775,141	56,222	365,341·26

For the Journal of the Franklin Institute.

Caloric Ship Ericsson.

Not having had the privilege, alone enjoyed by *reporters* of newspapers and Professor James J. Mapes, in an exhibition of the capacities and performances of this vessel, and entertaining a professional feeling regarding them of the deepest character, I ask the favor of a space in the Journal for a few brief questions, which, if correctly answered, are calculated to afford conclusive elements for an opinion of the actual physical results attained by this novel *arrangement* of a caloric engine, and of its probable utility.

1st. If the fuel expended by the *Ericsson* per hour had been added to that expended per hour by many of the larger class of side wheel steam tugs, would they not have towed her (her immersed buckets and water wheel arms removed) at the highest speed she attained in either of her trials? If not, why not? And if so, wherein is the economy of this caloric engine in fuel?

2d. What is the space occupied by the engines of this vessel, including coal stowage for the average period of five days, and what her speed in knots (sea miles) per hour?

3d. When the space occupied by engines of sufficient power to drive this vessel at a speed of 15 knots per hour, and the coal stowage required for five days, are fully provided for, how much less would it be than that which would be required by a steam engine and boilers capable of effecting the speed of fifteen knots, and with fuel for an equal period?

4th. This vessel being so far completed as to have made two trial trips, and her equipment being such as to enable persons to live on board of her, when is it that she will proceed on her first voyage?

STRAIGHT EDGE.

For the Journal of the Franklin Institute.

The Cunard Steamer Arabia.

This steamship, of which the particulars are published in the present number of this Journal, (vide page 122,) has recently arrived at New York, (Jan. 16th,) on her first trip, in 14 days and 11 hours running time from Liverpool, having passed 20 hours at Halifax, *coaling*. Total time from Liverpool, 15 days 7 hours.

She has been intended by her owners, from the time of laying her keel, to beat the Collins steamers, and no endeavor or expense has been spared to accomplish the purpose. It will be seen by the article referred to, that her length compared to her beam is very great, and that while her register tonnage does not exceed that of the Collins vessels, and her actual capacity is much less, her cylinder capacity is considerably greater, being the largest engine power placed on board any steamer in the world. How the intention, above referred to, has been fulfilled, will be seen when we state that the *Baltic*, which left two or three days before her, (Dec. 29th,) arrived on the 11th inst., in 13 days $3\frac{1}{2}$ hours, *real* time from Liverpool. Difference in favor of the *Baltic*, 1 day $7\frac{1}{2}$ hours running time.

The weather encountered by these two vessels was of course not materially different. If any difference existed it was certainly in the *Arabia's* favor, for before the A.'s departure, the *Baltic* encountered a gale in the channel, which added about 20 hours to her time.

This is the consequence of overpowering a vessel whose model is not adapted to a high rate of speed. While our transatlantic friends were "imitating Brother Jonathan by sharpening the bows," they had better have carried the imitation a little farther, by giving their vessel breadth

enough to secure stability and the proper strength. As it is, the ship, from all accounts, is very unsteady, and was strained by attempting to push her through at a high speed, while her consumption of fuel was enormous. She was certainly not sent away from Liverpool on an avowed race with the *Baltic*, without a reasonable supply of coal to carry her to New York; indeed, we are informed by the Liverpool papers that she had 1200 tons on board at her departure. Yet, on arriving off Halifax, she was obliged to put in for more.

When the end held in view in the construction of these ships is remembered, the *La Plata*, (formerly *Arabia*,) and the *Arabia*, (formerly *Persia*,) must be considered failures. The first has been running for some months past on the West India mail line; and neither of them, so far, has made speed which can at all compare with that of the Collins steamers.

For the Journal of the Franklin Institute.

Particulars of the Steamers Building or just Finished in the United States.

We give below particulars of the following steamers now building or just finished in the United States. The list is not as extensive as could be wished, and we trust that manufacturers will forward such information of the engines they are building as is given below, or any other deemed suitable for the *Journal*.

New York.—Steamer *John L. Stevens*, just finished for William H. Aspinwall, Esq., for the California trade. Hull by Smith & Dimon. Machinery by Stillman, Allen & Co.

HULL.—		
Length on deck,	285	feet.
Breadth of beam,	40	"
Depth of hold,	26	"
Tonnage, (Custom House,)	2202	tons.
ENGINE.—Single Oscillating.		
Diameter of cylinder,	85	inches.
Length of stroke,	9	feet.
BOILERS.—Two "drop flue."		
Length,	23	feet.
Breadth,	14	ft. 6 diam.
Depth,	14	" 6 "
Number of furnaces,	6	
Length "	7	feet.
Breadth "	4	feet each.
Grate surface,	168	sq. feet.
Total heating surface,	6066	"
Number of flues,	108	
Diameter "	13	inches.
Capacity of steam drums,	360	cubic feet.
Number of chimneys,	2	
Diameter of chimneys,	5	feet.
Height,	36	feet.
PADDLE WHEELS.—Ordinary Radial.		
Diameter over boards,	32	feet.
Length of "	10	"
Depth of "	20	inches.
Number of "	32	

New York.—Steamship *Augusta*, now building for N. York Savannah line. Hull by Wm. H. Webb. Machinery by Stillman, Allen & Co.

HULL.—

Length on deck,		220 feet.
Breadth of beam,		35 "
Depth of hold,		22 "
Tonnage (Custom House,)		1283

ENGINE.—Single Oscillating.

Diameter of cylinder,		85 inches.
Length of stroke,		8 feet.

BOILERS.—Two "rising flue."

Length,		28 "
Breadth,		11 feet diam.
Depth,		11 "
Number of furnaces,		6
Length "		7 feet 6 in.
Breadth "		3 " 10
Grate surface,		172½ sq. feet.
Total heating surface,		5200 "
Number of flues,		52
Diameters "		13, 14, 16, 17, 18 inches.
Capacity of steam drums,		390 cubic feet.
Number of chimneys,		1
Diameter, "		6 feet.
Height, "		36 "

PADDLE WHEELS.—Ordinary radial.

Diameter over boards,		30 feet.
Length of "		10 "
Depth of "		20 inches.
Number of "		32

Philadelphia.—Steamship *Keystone State*, for Philada. and Savannah line. Building. Hull by Vaughn & Lynn. Machinery by Merrick & Son.

HULL.—

Length on deck,		220 feet.
Breadth of beam,		35 "
Depth of hold,		21 "
Tonnage, (Custom House,)		1283 tons.
Length of engine and boiler space,		58 feet.
Draft when loaded, (to be,)		12 "
Contents of Bunkers,		160 tons.

ENGINE.—Single Side Lever.

Diameter of cylinder,		80 inches.
Length of stroke,		8 feet.
Steam pressure, (intended,)		22 lbs.
Cut-off,		variable.

BOILERS.—Two, return tubular, same as *State of Georgia*. (See Journal, xxiii. 409.)

Length of each over all,		16 feet.
Breadth,		12 feet 8 in.
Height, (except drum,)		11 feet 1 in.
" of drum,		12 "
Steam contents of both drums,	416	
" " of shells above water level, 12 in. over tubes,	846	
	——	1262 cubic feet.
Number of furnaces,		8
Width,		2 feet 7 in.
Length,		8 feet.
Grate surface,		166 sq. feet.
Heating " in tubes, (inside,)	4489	
" " furnaces, connexions, &c.,	1106	
	——	5595 "

Number of tubes,	480
Diameter of " (inside,)	3½ inches.
Length of "	11 feet.
Diameter of chimney,	6 "
Height of "	35 "

PADDLE WHEELS.—

Diameter over boards,	30 "
Length of "	9 feet 9 in.
Depth of "	1 foot 8 in.
Number of "	28

Philadelphia.—Steamer *Carolina*, (destination not given.) Hull by Wm. Cramp. Machinery by Reany, Neafie & Co.

HULL.—

Length on deck,	180 feet.
Breadth of beam,	30 "
Depth of hold,	8 "
Contents of bunkers,	20 tons.

ENGINES.—Two upright cylinder, geared to the propeller shaft, in the ratio of 1 to 2½

Diameter of cylinders,	40 inches.
Length of stroke,	3 feet.
Steam pressure,	20 lb per sq in
Cut-off at	½ stroke.

BOILERS.—Two "flue and rising return flue."

Length, each,		21 ft. 3 ins.
Breadth of furnace front,		8 feet.
" cylindrical shell,		7 " diam.
Height, (except drums,)		7 " 6 ins.
Steam contents in both,	280	
" " in shell above water level 9 in. above flues,	320	
	——	600 cubic feet.
Number of furnaces, (in both,)		4
Breadth of "		3 feet 4
Length of "		5 " 3
Grate surface, (in both,)		68¼ sq. feeet.
Heating " "		1700 sq. feet.
Number of flues, "		28
Length,		16 feet.
Diameter of flues, (inside,)		7 inches.
" of chimney,		5 feet.
Height of "		40 "
Weight of boilers filled,		40 "

PROPELLER.—

Diameter,	8 feet 3 in.
Length,	5 " 9 "
Pitch at periphery,	15 " 3 "
Number of blades,	4

Philadelphia.—Four coasting steamers now building, (names and destinations unknown.) Hulls, by Byerly & Son. Machinery by Reany, Neafie & Co.

HULL.—

Length on deck,	160 feet.
Breadth of beam,	24 "
Depth of hold,	11 "
Tonnage, (Custom House,)	435 tons.

ENGINE.—One direct action vertical cylinder, non-condensing.

Diameter of cylinder,	28 inches.
Length of stroke,	2 feet 4 in.
Steam pressure,	60 lbs.
Cut-off,	½ stroke.

BOILER.—One "flue and rising return flue."

Length,	21 feet.
Breadth, shell cylindrical,	6 "
Height, except drum,	6 " 6
Steam contents, drum and shell,	180 cubic feet
Number of furnaces,	1
Breadth "	5 feet 3
Length, "	4 " 9
Grate surface,	25 sq. feet.
Heating "	625 " "
Number of flues,	14
Diameter " (inside)	6 in.
Length of "	16 feet.
Diameter of chimney,	2 " 3
Height of "	25
Weight of boiler filled,	14 tons.

PROPELLER.—

Diameter,	8 feet.
Length,	5 " 6 in.
Pitch at periphery,	22 " 6 in.
Number of blades,	4

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*Photography:—The Fixation of Colors.**

M. Niepec de Saint-Victor laid before the Academy of Sciences, at the sitting of the 8th of November, daguerreotypes upon which he had succeeded in fixing, in a manner more or less permanent, colors by the camera-obscura. M. Niepec states, that the production of all the colors is practicable, and he is actively engaged in endeavoring to arrive at a convenient method of preparing the plates. "I have begun," he says, "by reproducing in the dark chamber, colored engravings, then artificial and natural flowers, and lastly, dead nature—a doll, dressed in stuffs of different colors, and always with gold and silver lace. I have obtained all the colors; and, what is still more extraordinary and more curious is, that the gold and silver are depicted with their metallic lustre, and that rock-crystal, alabaster, and porcelain, are represented with the lustre which is natural to them. In producing the images of precious stones and of glass we observe a curious peculiarity. We have placed before the lens a deep green, which has given a yellow image instead of a green one; whilst a clear green glass placed by the side of the other is perfectly reproduced in color." The greatest difficulty is that of obtaining many colors at a time; it is, however, possible, and M. Niepec has frequently obtained this result. He has observed, that bright colors are produced much more vividly and much quicker than dark colors:—that is to say, that the nearer the colors approach to white the more easily are they produced, and the more closely they approach to black the greater is the difficulty of reproducing them. Of all others the most difficult to be

* From the London Athenæum, November, 1852.

obtained is the deep green of leaves; the light green leaves are, however, reproduced very easily. After sundry other remarks, of no peculiar moment, M. Niepec de Saint-Victor informs us, that colors are rendered very much more vivid by the action of ammonia, and at the same time this volatile alkali appears to fix the colors with much permanence. These results bring much more near than hitherto the desideratum of producing photographs in their natural colors. The results are produced upon plates of silver which have been acted upon by chloride of copper or some other combination of chlorine. The manipulatory details have not been published, but we understand they are very easy.

For the Journal of the Franklin Institute.

Remarks on Incrustation in the Boilers of the Steamship Isabel.

A few weeks since the steamship *Isabel* came into this port for repairs of hull and machinery, and to replace her boilers. The boilers have been removed, and are now being cut up; an opportunity has thus been afforded to obtain the accompanying specimen of scale from her boilers, which, in the opinion of the writer, show an extraordinary degree of ignorance or negligence on the part of those persons having charge of her machinery.

If we are not mistaken, this vessel commenced her service in the winter of 1848, and the boilers have therefore been in use three and a half years; the ship plying semi-monthly between Charleston, Havana, and Key West: she is under steam an average of sixteen days per month, for ten months in the year; consequently, the boilers are now to be replaced after about six hundred days' service. The vessel being laid up for two months in each year for a general overhaul and repairs, it is to be supposed that *at such times at least* the scale is removed; in fact, the number of lamina in one of the pieces forwarded agrees with this supposition: therefore, this accumulation, estimated to amount to about a ton, has been deposited in less than a year.

It is commonly asserted, to exculpate careless engineers, that the water in the vicinity of coral reefs holds in suspension, in addition to the usual constituents of sea water, a quantity of carbonate and sulphate of lime. I am not aware that this assertion has been proved by an analysis of the water; but an experience of four years on board steamships in the Gulf of Mexico, satisfies me that no accumulation of scale to exceed one-sixteenth of an inch need be made.

These boilers have common return flues, and there could have been no difficulty in cleaning them, if inadvertently in a careless moment a small deposition had been made; but, unfortunately, many engineers confine their attention to the interior of the furnaces and flues, to the neglect of the interior of the boiler.

The scale averaged three-eighths of an inch thick over the shell, and upwards of half an inch on the flues and connexions; in some places not less than four inches thick: the greatest deposit in the vicinity of the back connexions, where it hung pendant like stalactites.

There can be, I think, no doubt but that this extraordinary accumula-

tion was caused by neglecting to blow, and carrying the water at a density approaching saturation. The loss occasioned by this neglect, independent of that caused by the short term of duration of the boilers, cannot be estimated at less than fifty per cent. in fuel; and we can only attribute their exemption from collapse to the thorough manner in which they are braced, and to the fact that the engines were short of steam, and worked it off with such rapidity as to keep the pressure below the point necessary to collapse red hot flues.

Specimen No. 1. Taken from over the furnace; iron in contact with it much injured, and showing evident marks of having been overheated; half an inch in thickness.

No. 2. Taken from an angle of the furnace, at the entrance of the flues; this specimen is completely vitrified; five-eighths thick.

No. 3. Taken from the vertical portion of the shell adjacent to the furnace. This specimen has not been in contact with red hot iron, and presents an entirely different fracture and appearance; five-eighths in thickness.

No. 4. Taken off a flue at the back connexions; presents a crystalline fracture, and marks of having been subjected to great heat; one inch and a quarter in thickness. N.

Baltimore, Md., August 20th, 1852.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, January 20, 1852.

Samuel V. Merrick, President, in the chair.

Thomas Fletcher, Vice President.

John F. Frazer, Treasurer.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Donations were received from the Royal Astronomical Society, London, Dr. David Dale Owen, U. S. Geologist; The Ohio Mechanics' Institute, Cincinnati, Ohio; T. H. Forsyth, Senate of Pennsylvania; The Legislature of Pennsylvania; Charles Ellet, jr., Esq., Theophilus Code, Esq., and Dr. C. M. Wetherill, Philadelphia.

Donations to the Cabinets from Wm. N. Jeffers, Esq., U. S. Navy, Professors J. C. Cresson and J. H. Alexander, U. S. Commissioners to examine steam boilers, and J. V. Merrick, Esq., Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of December; also, his annual statement of the Funds of the Institute.

The Board of Managers and Standing Committees reported their minutes.

The Committee on Publications reported their annual statement of the condition of the Journal of the Institute.